Railway Mechanical Engineer

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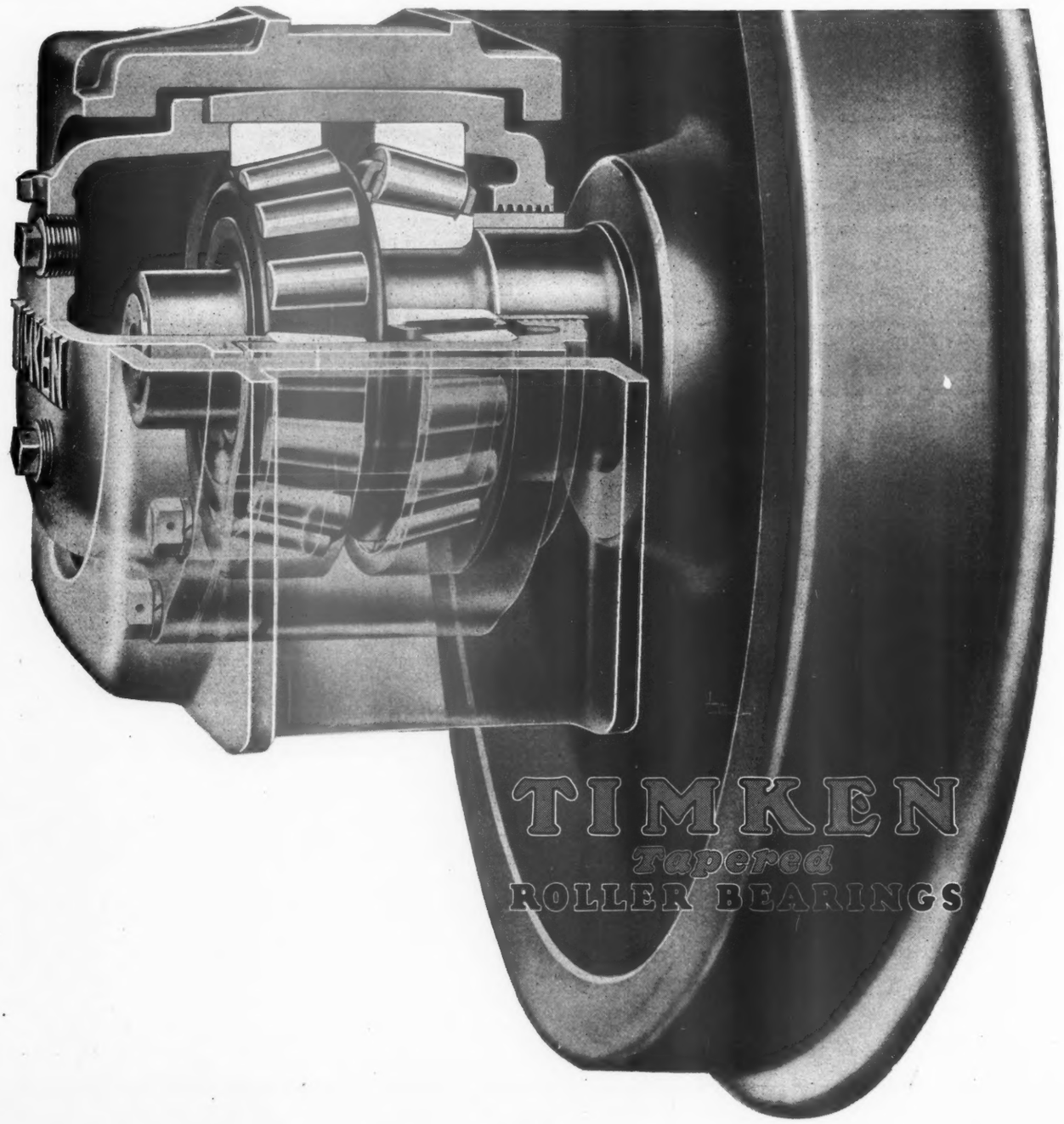

Railway Mechanical Engineer

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A big order for passenger cars

The announcement by the Pennsylvania, as we go to press, of an order, divided among a number of builders, for 613 all-steel passenger train cars of various types is not only attracting attention because it covers an unusually large number of passenger cars for a single order, but because it practically marks the completion of the retirement of wooden cars from regularly scheduled steam passenger trains for the entire Pennsylvania system, and their substitution with all-steel equipment. The Pennsylvania was one of the first roads to install all-steel passenger cars on an extensive basis and during the past 21 years has built no wooden cars. Last year the railroad retired 559 wooden cars and announces that, with the completion of the program now under way, there will still remain in operation approximately 200 wooden passenger carrying cars which, however, will only be used for extraordinary or emergency purposes. Some notion of the importance of this order may be gained from the fact that the total number of orders for passenger coaches placed in the United States last year amounted to 1,868, of which orders placed by the Pennsylvania amounted to 328. Of the cars in this year's order, all of the 320 combination and passenger carrying coaches will be equipped with anti-friction bearings. There are probably few, if any, steam railroads in the United States which will be as nearly 100 per cent equipped with all steel passenger train cars in revenue service as will the Pennsylvania on the completion of the present program.

The car inspector

Few groups of employees in the ranks of railroad companies are of greater importance in connection with transportation than the car inspectors. Upon these men rest the serious duties of safeguarding life and property to an extent not always appreciated. In order to perform such duties properly, car inspectors must be not only reliable and loyal but thoroughly familiar with the anatomy of passenger and freight cars, the A. R. A. mechanical rules of interchange, the A. R. A. loading rules, the general safety appliances regulations, the regulations covering the transportation of explosives and other details. Every effort should be made to encourage car inspectors to become members and take an active part in the proceedings of the nearest car foremen's association and, in addition, to do as much reading as possible of technical publications and books relating to both car department and general railway operation.

Aside from the advantages which will accrue to railroads in assisting and encouraging car inspectors to improve their knowledge of car department details and widen their understanding of railway operation as a whole, there is no question that the roads will be developing a valuable source on which to draw for foremen and higher supervisory officers. Almost every month, news is received of the appointment of some man to the position of general car foreman, shop superintendent or superintendent of the car department who started his work in railroad service as a humble car repairer or inspector. Car inspectors need and deserve all of the aid and encouragement which can be accorded them in performing their arduous and important duties.

Facts about draft gears

It is an undeniable fact that modern freight car weights and train operating speeds have increased to a point where the dimensions of the standard draft gear pocket are hardly sufficient to give the manufacturer much leeway in his attempt to design a draft gear which will satisfactorily absorb the shocks and prevent damage to the car structures and lading. A prominent car builder says that the draft sill spacing should be increased to give the draft gear engineers a chance to exercise their ingenuity in designing spring and friction elements of larger size to reduce wear and prolong the life and generally satisfactory performance of the gears. A superintendent of motive power, on the other hand, says that increased travel is more necessary in order to increase the time available for the development of the full cushioning effect in the gears.

The existence of free slack in draft gears and their connections in cars is also a fact and admittedly one of the most damaging conditions which have to be confronted and overcome. The average total slack between two freight cars is nine inches, but this distance, in many cases, is considerably exceeded due to wear in the draft gear parts and the stretching and displacement of draft lugs, and stops. One of the first and most important steps which should be taken with a view to improving draft gear maintenance conditions would be to inspect cars at every opportunity for evidence of slack action and take the necessary steps to see that this feature is maintained within proper limits.

Many other important facts about draft gears could be mentioned, but space is available in this editorial for only one more; draft gears in general are not receiving the attention they should at the time cars receive gen-

eral repairs and a thorough overhauling of all other parts. Draft gears are recognized as a vital element in car design but because broken parts, spring set and undue wear of friction elements often cannot be seen, general repair cars are in many cases returned to service with their draft gears in exactly the same condition as regards defective parts and insufficient capacity as when received at the shop.

Evidence of this lack of attention to draft gears is all too frequent. Records show that one car, to mention a single example, was shopped four times in one month for broken end sills, the damage being charged to rough handling when really due to defective draft gears. In each case except the last, the car was returned to service with the identical gears which caused the trouble. Freight car maintenance standards cannot be satisfactorily raised and repair costs per mile reduced until a more general appreciation of the influence of deficient draft gears in contributing to car damage obtains and steps are taken to replace or repair those gears which do not meet modern requirements.

On every railroad of any considerable size there are a number of box cars originally built with steel underframes and wood superstructure. From time to time these cars require rebuilding after having been in service for a number of years. At this point a question arises as to whether or not it is advisable to rebuild such cars in kind or to replace the wood superstructure with steel. In order to arrive at an answer to this question several factors must be considered: Providing the car is rebuilt with steel superstructure instead of wood what may be said of the life of the car when rebuilt as compared with its original construction? Will the cost of rebuilding the car with steel superstructure be greater or less than the original construction and, if greater, will the additional cost be justified? Can the steel car be expected to give as satisfactory service as the original car and will its cost of maintenance in service be greater or less?

Is this problem important?

When it is considered that year after year thousands of cars of this type are rebuilt in kind it would almost lead to the conclusion that car department officers on the majority of our railroads have either not considered the advisability of rebuilding such cars with steel superstructure or, having considered it, have decided that because so little seems to be known about the real cost of all steel box cars, they cannot afford to experiment with the unknown. The relative length of life of steel construction in cars as compared with wood seems not to have been very well established as yet. The cost of replacing wood with steel is another question that involves considerable study since railroads that are accustomed to repairing wood superstructure cars in kind are not thoroughly familiar with steel work. It is of advantage to rebuild such cars in kind for the reason that most roads have facilities available for handling that kind of work and the forces employed are accustomed to the work through many years of contact; but what can be said of the cost of maintaining wood superstructure cars in service, and is enough known about the cost to decide whether or not economies might be effected by a change in construction? The operation of cars of this type in service over a period of many years has made it possible to determine accurately what the disadvantages of this type of construction are.

From a structural standpoint experience seems to indicate that the all-steel car has many advantages. The problem which immediately arises when all-steel construction is considered is that of protection against deterioration. The service life of a steel car seems to bear a direct relation to the life of its paint and the problem of adequate surface protection for steel cars involves several factors, not the least important of which is the cost of sand blasting.

During the coming year it is going to be necessary to rebuild many thousand more cars of composite construction. Shall they be rebuilt in kind or with steel superstructure? Is this problem really a problem at all and if so, how should it be solved?

A few years ago pressures exceeding 250 lb. and temperatures over 500 deg. F., were seldom used in any industry. Pressures up to 1,400 lb. and temperatures as high as 750 deg. are now being used in power plant boilers and pressures of 900 lb. and temperatures above 1,000 deg. in oil refineries. Recent developments in locomotive design, especially in Europe where fuel consumption is relatively more important than in the United States, have been toward the utilization of the so-called super pressures. Three designs of super pressure locomotives have been built. One of these is the Schmidt-Henshel locomotive and the second is a super pressure locomotive, built by the Swiss Locomotive Works, which generates all the steam at 850 lb. and uses a high speed triple expansion engine with gear transmission for driving. A third locomotive built by J. A. Maffei, Munich, Germany, is now being tested. This locomotive is equipped with a Benson boiler which generates steam at nearly 3,400 lb. pressure and over 700 deg. F.

Metals for high temperatures and pressures

Developments toward higher boiler pressures have also been going steadily forward in this country although not to the same extent as in Europe. The Delaware & Hudson has in service its John B. Jervis locomotive which generates steam at 400 lb. pressure and has only recently placed in service a locomotive of standard firebox construction which generates steam at 300 lb. pressure. The Pennsylvania is engaged in the design of a 2-10-0 type for 450 lb. pressure.

American locomotive designers are pursuing a more conservative policy than that being followed by engineers in Europe. The most radical changes in boiler design that have been made so far in this country have been in the construction of the firebox. Some attention has also been given to the development of various modifications of boiler construction which will permit more satisfactory service, but not to the extent as in Europe. Furthermore, the new developments in America have not only been with the object of using higher pressures, but also to secure better water circulation and to reduce corrosion.

Locomotive designers in America are inclined to favor the present general type of locomotive boiler and if possible, work to develop it for generating steam at higher pressures. There is no doubt, if proper materials are developed for use in boiler construction, that the present design or modification thereof, can be used for considerably higher temperatures and pressures than are now being used. The possibilities that such materials already exist and are being further developed

was brought out by V. T. Malcom, metallurgical engineer, The Chapman Valve Manufacturing Company, Indian Orchard, Mass., at a recent meeting of the New York chapter of the American Society for Steel Treating.

He said, "Materials are certainly available for use at high temperatures and while there is room for a difference of opinion in the matter, this difference can hardly be extreme. The more complete recognition of the fundamental principles involved and the growing accumulation of practical working data, combine the truly remarkable properties of metals and alloys investigated, making possible for a large number of operations a degree of precision of safety heretofore thought impossible. This will in time result in continuous accurately controlled operations and the development of new processes not feasible at this time. Technical industry and research laboratories are beginning to understand each other and many of the highest hopes of industry are based on the prospect of more intimate co-operation. We can not see, therefore, how special metals can be of importance in affecting the destinies of engineering progress. It is not a difficult matter to increase pressures, because they can be taken care of in many instances by simply increasing the thickness of the metal. But increases to higher temperatures must be made more slowly and with greater caution. There is no doubt that all of us would like to see the ideal metal possessing, as it would have to, innumerable contradictory qualities, but we do not believe that it is wise to sit down and wait for this metal. In our opinion it is far better to proceed with metals now available and we believe that contrary to certain opinions that progress is still possible with the use of existing metals."

This statement by Mr. Malcom would seem to justify further development of the present type of steam locomotive boiler. As he points out, progress is being made in the development of metals to withstand higher temperatures and pressures. Such being the case, it seems the better part of wisdom to continue this development work utilizing the knowledge of the metallurgist and the facilities afforded by the research laboratory to obtain improved materials for boiler construction. This knowledge combined with an analytical study of the developments of boiler construction that are going on both in this country and in Europe, should eventually result in the procurement of a boiler able to supply steam to the cylinders with maximum economy and efficiency, and with a minimum of departure from the present type of boiler construction.

Discussing the car interchange rules

The letter to the editor from a reader, which was published on The Reader's Page of the May, 1927, issue of the *Railway Mechanical Engineer*, asking whether or not substituting wrought iron yokes for cast steel constituted wrong repairs, started a very interesting discussion in which several other readers have taken part. The variety of answers to this question revealed a considerable divergence of opinion. In fact, some of the arguments were so well presented that doubtless many of those who followed this discussion wondered if, perhaps, a number of good railroad men could not have done well in the practice of law in Philadelphia. At any rate, the discussion revealed a situation or a condition of mind which showed the real value of the Arbitration Committee and its work.

There will always be differences of opinion which can only be settled by the rulings of the Arbitration Committee. In this particular instance it has seen fit to add interpretations 23 and 24 to Rule 17 which are published in the new code of rules, effective January 1, 1928. The question in interpretation 23 reads as follows: "In connection with Section (a), Rule 17, is the substitution of an A.R.A. standard wrought iron riveted yoke in replacement of a broken cast steel key yoke considered wrong repairs?" The answer by the committee reads that "Such substitution impairs the strength of the original construction and, therefore, constitutes wrong repairs subject to Rule 88; a defect card to be issued for labor only in case of the owner's responsibility."

This decision settles the controversy. It agrees substantially with the opinion expressed by the editor in the July, 1927, issue which was published in reply to a question by Wm. S. Elder, McKee Rocks, Pa.

Interpretation 24 reads: "In connection with the substitution of a wrought iron yoke for a cast steel yoke which is not defective, in case the riveted yoke coupler is applied on account of an A. R. A. type D coupler being defective, is the repairing line justified in allowing only scrap credit for the cast steel yoke removed?" The answer to this question is, "No." This decision also settles one of the controversial points that was brought up in the discussion.

Discussions not only on interchange rules, but on subjects such as car loading rules, A. R. A. standards and recommended practice, or I. C. C. defects are not only of interest but are of considerable value to the readers of the *Railway Mechanical Engineer*. On The Reader's Page of this issue is another question relative to interpretation 25 of Rule 7 of the interchange rules. This in all probability, is a development of the discussion started last May. Doubtless there are many who believe that they can answer this inquiry. Many opportunities are afforded by discussing your problems in these columns. You often bring your problems to the attention of those who can be a real help in arriving at a final solution.

New Books

BULLETIN OF THE NATIONAL RESEARCH COUNCIL. Compiled by *Clarence J. West and Ervye L. Risher. 6¾ in. by 9¼ in., 153 pages. Published by The National Research Council of The National Academy of Sciences, Washington, D. C. Price, $1.00.*

This bulletin is the third edition, revised and enlarged, and is published to meet the demand for information regarding industrial research laboratories in the United States. It contains a list of all laboratories in this country about which the compilers were able to obtain information; the name and address of the company supporting the laboratory, and the address of the laboratory if different from that of the company; the name of the director of research and the number of engineers on his staff, and the chief lines of research work carried on at the laboratory. The present revision contains data pertaining to 1,000 laboratories, a considerable number of which are laboratories maintained by railroads and railway supply companies.

Proposed high pressure water tube boiler

Greater efficiency and tractive force may be developed with boiler designed for 500 lb. pressure

By Louis A. Rehfuss

THE passage of years will unquestionably bring a wide demand for increased power and efficiency in the use of steam locomotives. The staybolted, firetube type of boiler with which our present day locomotives are equipped, seems ill adapted to reach into these fields. The several types of firetube boilers with watertube fireboxes now being tried seem but a transitory step towards a distinct change in design, which will definitely feature all-watertube boilers, already so strongly entrenched in the stationary field. The latter, because of the limited diameters of all pressure containing sections, may be extended for use to any pressure which the future may demand.

The first difficulty encountered in designing the proposed all-watertube locomotive boiler for a pressure of 500 lb. was the disposal of the watertubes in the barrel section of the boiler. If these tubes are placed longitudinally and at too low an angle, the degree of overload rating to which the boiler could be driven is limited. If we arranged these vertically our tubes would become too short and the number of joints excessive. By arranging the tubes inclined in the manner shown in the accompanying drawings these difficulties, we feel, are largely overcome. The tubes are kept straight and thus easily cleaned and replaced and are sufficiently pitched and short enough to stand the high degree of overload rating required in locomotive practice. By pitching the tubes from the front and rising to the rear, we obtain a counter current circulation of water and gases, considered so desirable by boiler authorities. This enables the water to keep rising into gases of progressively higher temperatures, thus aiding the steam formation. It also enables the low temperature gases to do more work, as they strike the coolest end of the system, where the feedwater is introduced at the front end of the lower drums, just before these gases pass into the smokebox.

Stress placed on combustion efficiency

One noteworthy feature of the proposed boiler is the emphasizing of combustion efficiency at the expense of evaporative efficiency. That over-emphasis has been placed in the past on evaporative surface can be readily shown. From test data it has been estimated that in a normal firetube boiler the flue length could be cut to two-thirds its normal amount without affecting the flue evaporation more than nine per cent and the overall boiler evaporation (firebox included) more than five per cent. It is also claimed that half the flues could be plugged up without affecting the flue evaporation more than four per cent, which would make the overall boiler evaporation loss little more than two per cent. In the former case, the draft would be less than normal and in the latter much more than normal. Actually we should be able to cut the total boiler evaporation surface by 35 or 40 per cent, and by keeping the draft normal by proper sizing of the flue passages, while the gas weight remains constant, it is unlikely that the total evaporation would be more than three or four per cent below that of the ordinary heavily tubed boiler. A design which gives a vigorous water circulation would tend to eliminate even this small loss by increasing the unit surface evaporation.

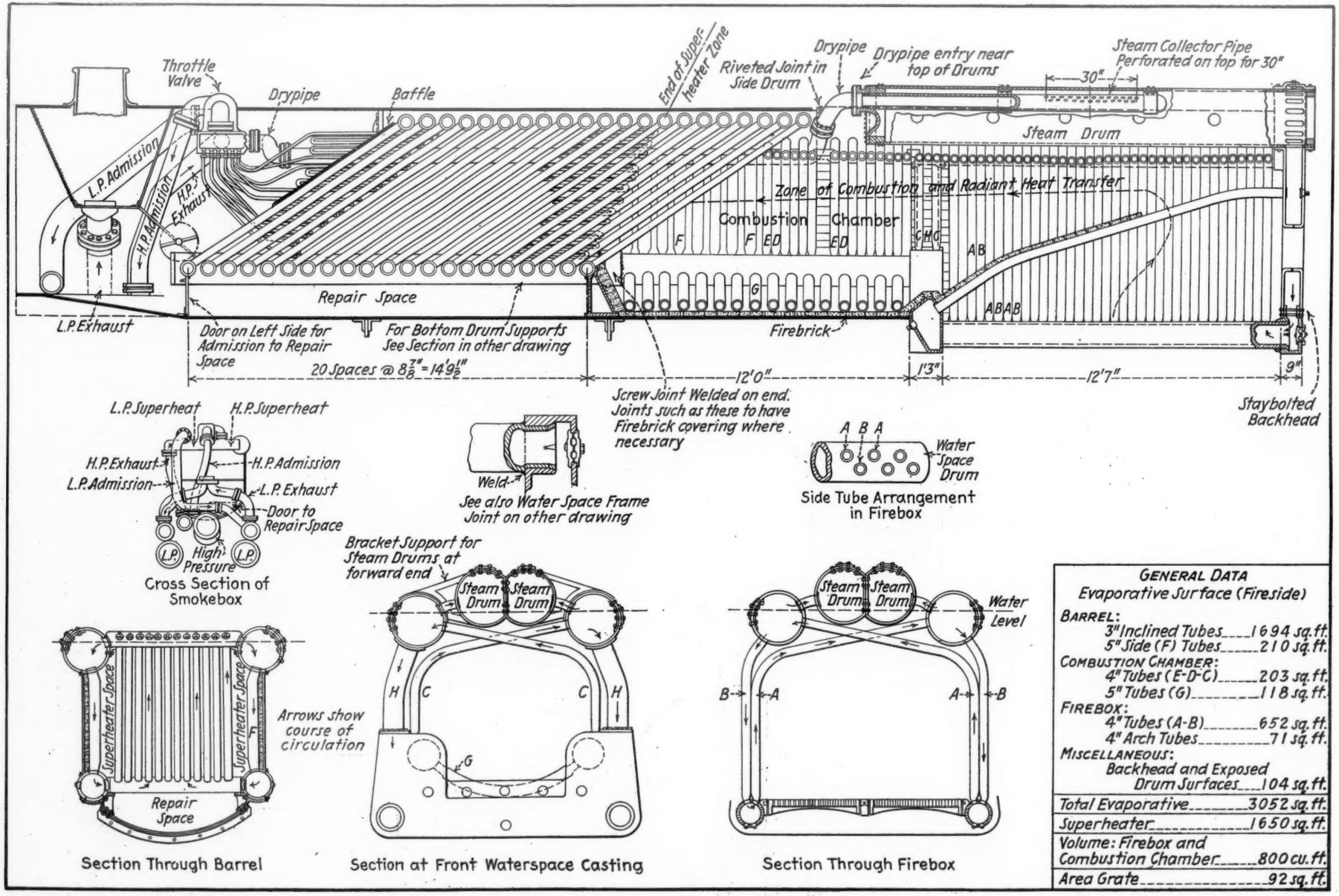
If this tube space saved were added to the firebox and combustion chamber, it is reasonable to suppose that the unburned fuel loss, which reaches 25 per cent to 30 per cent at full power, would be greatly lessened, because the gases would stay in the combustion space long enough to burn the floating carbon particles. Curves plotted from tests based on coal burned per cubic foot of firebox volume, particularly in the case of the higher volatile coals, show strikingly the value of this additional firebox volume; and in recent stationary installations, rates of operation are commonly measured in terms of coal burned per cubic foot of firebox volume as a contrast to grate area.

It is evident from an examination of test reports, particularly at the higher rates of burning, that combustion inefficiency is the greatest waste we have in locomotive boiler operation, so that design should give it the most consideration. The reverse has been the case with locomotive boilers to date, partly due to the fact that the expansion of heated crown sheets, where the latter were made too long, gave trouble from staybolt breakage. The proposed design permits the combustion chamber to be made as long as desired.

A further aid to combustion efficiency is the inclined tube arrangement rising to the rear. This enables sparks which strike it to be deflected to hot bricks in the floor of the combustion chamber where they may be consumed.

Advantage of the air preheater

To improve the combustion efficiency still more a proposed innovation is the air preheater. Test plant results have shown that while some oxygen remains in the smokebox gases, actually in many cases there is not nearly enough to consume the unburned fuel loss at full power rates, even had the gases been left in the combustion chamber long enough for thorough combustion. From four to eight per cent of free oxygen is desirable in the smokebox gases. When the coal burning rate is raised over 100 pounds per square foot of grate per hour, many locomotive tests show this oxygen as low as two per cent. It is evident that some means for adding air to the firebox is desirable, but it should be preheated to avoid chilling the gas mixture. The location of this preheating air system is not shown, but in place of the firebrick in the side walls of the waist section, a corrugated plate may be used back of the side circulation tubes, between which and the cover plate the air may pass, driven from the front by the velocity of the engine and heated by the heat that would normally strike the firebrick. While at first glance this may seem as though



GENERAL DATA

Evaporative Surface (Fireside)

BARREL:	
3" Inclined Tubes	1694 sq. ft.
5" Side (F) Tubes	210 sq. ft.
COMBUSTION CHAMBER:	
4" Tubes (E-D-C)	203 sq. ft.
5" Tubes (G)	118 sq. ft.
FIREBOX:	
4" Tubes (A-B)	652 sq. ft.
4" Arch Tubes	71 sq. ft.
MISCELLANEOUS:	
Backhead and Exposed Drum Surfaces	104 sq. ft.
Total Evaporative	3052 sq. ft.
Superheater	1650 sq. ft.
Volume: Firebox and Combustion Chamber	800 cu. ft.
Area Grate	92 sq. ft.

Sectional views of proposed high pressure all-water tube type locomotive boiler

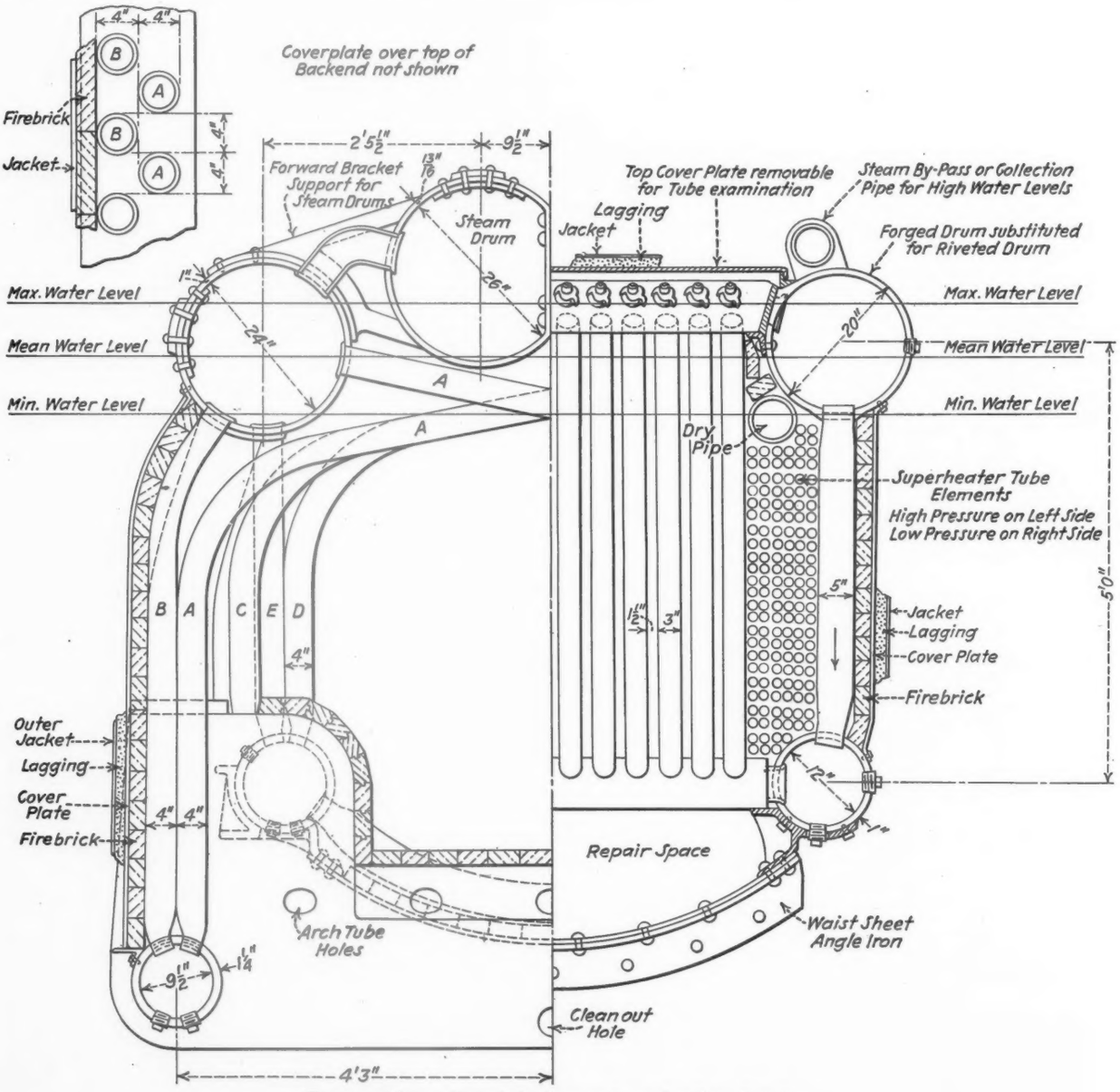
the hot water in the downflow pipes is robbed of a little heat to send back to the firebox, in reality it is more than this. The gain comes from the greater addition of oxygen at times when most needed, resulting in a higher combustion efficiency than could otherwise be obtained. This air supply could be controlled by a shutter arrangement.

While the evaporative surface has been limited to 3,000 sq. ft. in the present design, which is only 60 per cent to 65 per cent that of a comparable firetube boiler, nevertheless because of the rapid water circulation, it is felt that the evaporative efficiency will be up to normal.

that not only the live coals, but the hot gases themselves at high temperature emit a considerable percentage of radiant heat, so that radiant heat absorption is not limited to surfaces which 'see' the fire. This conception of radiant heat is comparatively new, but illustrates the fact that the evaporative surface lining a long combustion chamber is not limited to convection contact for its heat absorption.

Double superheater employed

The superheater proposed is a double one. The high pressure of 500 lb. employed permits the steam to ex-



Cross sections through firebox and combustion chamber

The boiler sections in the drawings show this circulation by arrows. The considerable pitch of the inclined tube system, setting up a vigorous, *countercurrent* circulation, should give a considerably higher unit evaporation than is customary in normal firetube practice. The long combustion chamber permits a higher percentage of radiant heat absorption than usual, so that the barrel tubes have relatively less to do. It is a known fact

haust from the high pressure cylinder at approximately 200 lb., so that superheating intermediately becomes an attractive proposition. In fact, in order to get the full thermal benefits of the high pressure proposed, this intermediate superheating should be employed. In the proposed boiler the left half of the superheater is devoted to high pressure superheating, while the right side superheats the steam between the high and low

pressure stages. In this way the initial temperature of the steam is kept well within the 700-deg. temperature limit considered advisable. Due to the density of the steam, the capacity of the superheater should be ample and this very density should increase the heat transfer per unit of superheater surface. At 500 lb. pressure one pound of saturated steam has a volume of only 0.90 cu. ft. and a temperature of 470 deg. F., compared to 2.14 cu. ft. and 388 deg. F. for 200 lb. pressure steam. The smokebox arrangements for this compound superheating are indicated on the drawing.

It will be noticed from the print that the water line is shown below the bottom of the upper headers of the inclined tube system. This is an advantage, however. Where tubes enter a water drum considerably below the water line, the weight of water above causes the steam formation to become intermittent and explosive at high rates of firing. Experiment has shown on the other hand, that where watertubes deliver above the water line, the steam formation causes a syphon-like action, which only becomes stronger and more continuous the higher the fires are forced. Thus a wide variation in the water line is permissible in the proposed design, taking care of unusual steam demands; and any overheating of the tubes at unusually low water levels is kept within safety bounds by the stronger syphon action that occurs at such times. The main steam drums receive only secondary heat from the fire, so that they are in no danger of overheating. This is also true of the inclined tube headers.

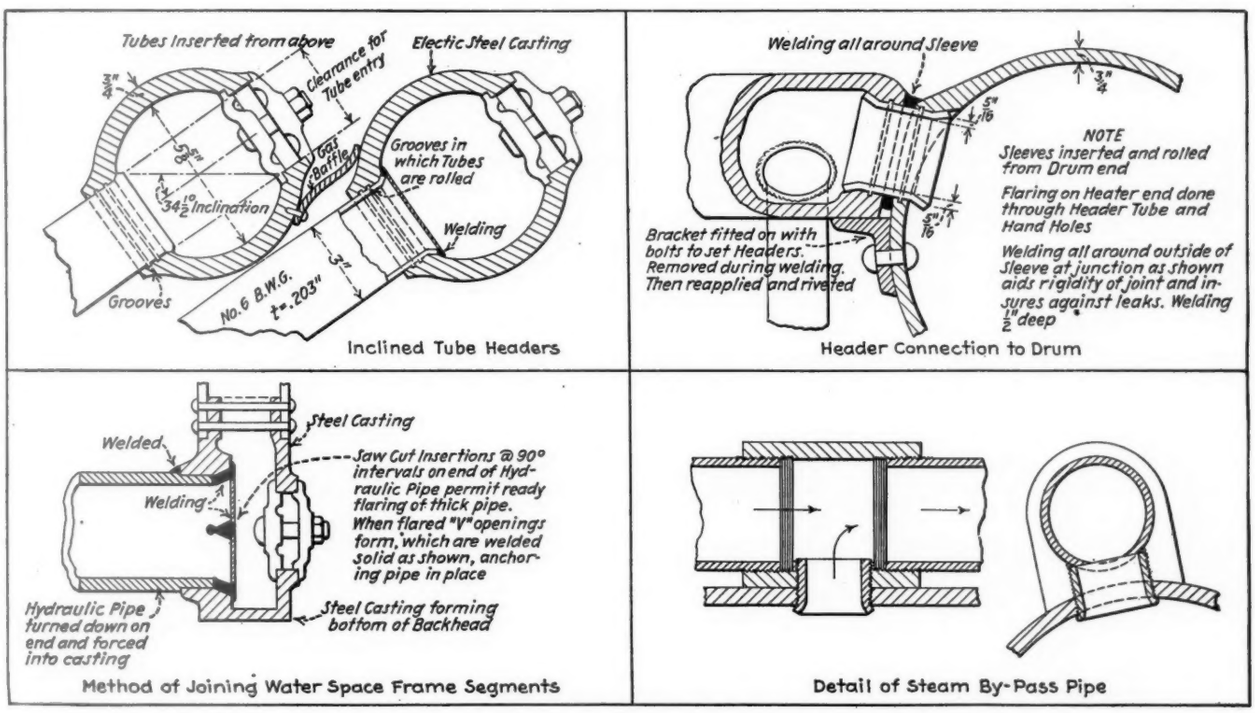
The steam by-pass or collection pipe is provided to take care of steam collection in the forward portion of the upper side drums when the water levels run too high or when surges of water in starting or on hills cause temporarily high water levels in part of the system.

Dry steam is assured by the fact that the main portion of the dry pipes is at a lower level than the steam entrance into the superheater header. The dry pipes hence collect the moisture, which tend to protect them from the hot gases with which they come in contact.

The construction of the proposed boiler with drums on the four corners of square cross section, makes it easy to brace by any strap construction desired. This detail has been omitted from the drawings in order not to destroy their clarity.

The overall weight of the boiler is somewhat large, but the lesser water weight carried as compared to a firetube boiler partially overcomes this objection. The weight of the proposed boiler, for 500 lb. pressure, including firebrick linings and various cover plates, but exclusive of superheater grates, lagging and jacket, is approximately 135,000 lb. empty and 162,000 lb. loaded with water to the water line. A 200 lb. pressure firetube boiler of about similar power would weigh around 105,000 lb. empty and 155,000 lb. loaded with water to the water line. The boiler is designed for approximately 4,000 cylinder horsepower.

The first cost of a normal boiler is only about one-third the cost of a locomotive as a whole, so that the boiler first cost might be increased considerably without increasing the locomotive first cost, unreasonably. This would be justified if thereby sufficient savings in operation and maintenance cost could be attained, or if the ton-mile costs could be reduced through the building of more powerful locomotive units.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Inclined Tube Headers
Welding all around Sleeve
NOTE
Sleeves inserted and rolled from Drum end
Flaring on Heater end done through Header Tube and Hand Holes
Welding all around outside of Sleeve at junction as shown aids rigidity of joint and insures against leaks. Welding 1/2" deep
Bracket fitted on with bolts to set Headers. Removed during welding. Then reapplied and riveted
Header Connection to Drum
Steel Casting
Welded
Welding
Saw Cut Insertions @ 90° intervals on end of Hydraulic Pipe permit ready flaring of thick pipe. When flared "V" openings form, which are welded solid as shown, anchoring pipe in place
Hydraulic Pipe turned down on end and forced into casting
Steel Casting forming bottom of Backhead
Method of Joining Water Space Frame Segments
Detail of Steam By-Pass Pipe

Details of header and drum connections, water space frame segments, and steam by-pass pipe

Advantages of proposed boiler

To recapitulate, the expected advantages of the proposed boiler are:

1. *High pressure*—The drawings are made for a 500 lb. per sq. in. pressure boiler, but the general design, because of the limited diameter of all sections, could with limited changes be readily employed for extension to 1,000 lb. or whatever the future might demand. Aside from the thermal efficiency involved, the fact that such steam occupies such small volumes per-

mits the use of greater power within limited cylinder diameters than has heretofore been possible.

2. *Superior combustion efficiency*—particularly at higher rates of firing. This makes it possible to couple large grate areas with higher rates of burning and thus secure higher powers than have been customary in the past.

This superior combustion efficiency is obtained by:

(a) A *long, open flameway,* with a design which permits the combustion chamber to be made any length desired.

(b) *Inclined tube arrangement* as an aid to deflecting sparks, causing them to fall on hot bricks where they may be consumed.

(c) *Use of preheated air, if desired.*

3. *Superior circulation,* which materially overcomes the handicap to evaporative efficiency occasioned by a comparatively small amount of evaporative surface. This also lessens the scaling effect of bad waters and reduces priming.

4. *Quick steaming*—It should be possible in a watertube boiler of this type to raise steam from cold water in half the time it takes with the ordinary firetube boiler.

5. *Compound superheating*—This is made advantageous because of the high pressure employed.

6. *Safety from crown or other extensive explosions.*

7. *Steam capacity*—With steam at 0.90 cu. ft. per pound, it is possible to store 2.4 times the weight of steam in the same space compared to 200 lb. pressure steam. Measured in actual *volumes* the proposed boiler has but 60 per cent of the steam capacity and water capacity of a comparable firetube boiler. Actually the steam storage capacity measured in terms of weight is about 45 per cent greater than that of a 200 lb. pressure locomotive. In terms of power it is about twice as great. Owing to the syphon action of the tubes and the absence of crown sheet, a wide variation in water line may occur without serious danger to the boiler.

8. *Maintenance*—Objection to the number of joints to be kept tight is counterbalanced by the fact that there are no staybolts to maintain except in the backhead. Even these might be eliminated by employing circular waterlegs for the back connection between top drums and water-space frames, but such waterlegs should be large enough to permit a generous circulation at the back.

Welding of joints

The judicious use of electric welding should take care of most of the joints in the actual construction. Take the header connections to the drums, for example. As finally assembled and welded before tubes are installed, these headers make a permanent connection to the drums almost as solid as a casting. They should require no maintenance. The lower drums made from hydraulic pipe or steel castings may be machined on the ends a trifle larger than the bore they enter and either forced on under hydraulic pressure or shrunk on. Serrations or grooves in the tube hole entrances permit the smaller tubes to be tightly rolled, as well as increase the holding power three-fold over smooth bores. They should then be flared and welded through the handholes.

The removable cover over the top of the inclined tube system enables the tubes to be readily examined, and these tubes can be thoroughly scaled without removal, a valuable asset in bad water districts. Being straight they can be readily replaced without disturbing any section of the boiler.

Heat available for steam generation

Let us assume by way of comparison a 200 lb. pressure firetube locomotive boiler of normal design, equal grate area, and approximately equal overall dimensions. At normal full power, and a grate area of 92 sq. ft., such a boiler would burn 120 lb. of coal per sq. ft. of grate per hour, or 11,000 lb. in all. With this coal rate, test plant results would indicate the following log:

	Per cent
(a) Heat utilized in evaporation	58.5
(b) Loss in unburnt fuel	24.0
(c) Loss in smokebox gases	13.5
(d) Loss in radiation, etc.	4.0

In the proposed high pressure watertube boiler, while the net results should be somewhat better, it is not anticipated that it would be materially so, due to all smokebox gas losses. The more limited amount of evaporative surface in the proposed watertube design, as well as the higher temperatures of the high pressure steam, would cause the smokebox gases to leave at higher temperatures. These losses, however, would be greatly minimized by the vigorous water circulation (which would increase the unit tube evaporation), by appropriate baffling (which would increase the gas velocity and length of gas travel), and finally by the superheating of heated steam temperatures within normal limits. Considering all of these factors within the light of the data made available by test plant results, the indication is that this loss in smokebox gases for the proposed watertube design should be placed at 16 per cent.

On the other hand, the design of this boiler is particularly built around an improved combustion efficiency, provision being made for an exceptionally long flame travel, as well as the use of preheated air. It is thought reasonable to estimate the unburnt fuel loss at not over 20 per cent. The heat log of the watertube boiler then becomes:

	Per cent
(a) Heat utlized in evaporation	60
(b) Loss in unburnt fuel	20
(c) Loss in smokebox gases	16
(d) Radiation and other losses	4

Assuming coal at 13,500 B.t.u. per pound, we then have available for steam generation in the two boilers:

Watertube: $11{,}000 \times .60 \times 13{,}500 = 89{,}200{,}000$ B.t.u. per hour
Firetube: $11{,}000 \times .585 \times 13{,}500 = 87{,}000{,}000$ B.t.u. per hour

Steam generation

The particular advantage of high pressure steam lies in the fact that as the pressure goes up, the heat of vaporization, or non-productive heat, decreases, so that the total heat contents of a pound of steam at 500 lb. pressure is virtually the same as steam at 200 lb. This is true of saturated steam, although in the superheating of the steam the specific heat is greater for higher pressure steam.

The heat required to form a pound of superheated steam in the two cases is as follows:

	500 lb. Watertube	200 lb. Firetube
Heat for saturated steam (above water at 60 deg.)	1,172	1,171
Initial superheating	90	133
Secondary superheating	90	....
	1,352 B.t.u.	1,304 B.t.u.

Assuming that a feedwater heater introduces 125 B.t.u. from exhaust steam sources, the net heat required from the fire to form a pound of steam in the two cases becomes respectively 1,227 and 1,179 B.t.u. The resultant steam formed per hour becomes, watertube, 72,700 lb.; firetube, 73,800 lb. or practically the same. It is evident from the foregoing that no substantial increase is expected in the amount of steam

formation from the design of the watertube boiler. While improved combustion and improved circulation increases the amount of evaporation, this is offset by higher temperatures in the smokebox gases. To attempt to absorb this heat by the use of economizers and added evaporative surface simply means increasing the weight, cost, and size of the boiler considerably for the sake of a small increase in boiler efficiency, which is not justified when the low heating efficiency of smokebox gases is considered.

The real gain in the proposed design lies in the very much improved water rate made possible by the high pressure, aided by compound superheating. Compound superheating in its turn is made possible by the small volumes which steam occupies at high pressures, and would not be advisable for low pressures.

In the case of a modern firetube locomotive working at 200 lb. pressure the water rate would vary from 16 to 22 lb. of steam per i.hp-hr. Let us for the sake of our calculation, assume this at 17.5 lb., which would be very good.

Now theoretically an increase in pressure from 200 lb. to 500 lb. will give a gain of 3 per cent in power. Practically, due to the inability to obtain the full expansion ratios required, as well as to higher condensation losses, it is not feasible to realize all of this gain. However, by the use of two-stage expansion and intermediate as well as initial superheating, it should be possible in the 500 lb. pressure watertube design to lower the water rate to a figure between 13 and 15 lb. per i.hp. hour. This is borne out by test plant results realized with a 350 lb. watertube locomotive firebox boiler.

Assuming a water rate of 14 lb. for the high pressure watertube design and 17.5 lb. for the 200 lb. firetube boiler, the probable power output of the two designs becomes (inclusive of auxiliaries):

$$\text{Watertube:}\quad (500\text{ lb.})\ \frac{72{,}700}{14} = 5{,}190\text{ i.hp.}$$

$$\text{Firetube:}\quad (200\text{ lb.})\ \frac{73{,}800}{17.5} = 4{,}220\text{ i.hp.}$$

The corresponding coal rate for the case in hand, at 120 lb. of coal per sq. ft. of grate per hour becomes:

$$\text{Watertube:}\quad \frac{11{,}000}{5{,}190} = 2.12\text{ lb. of coal per i.hp.-hr.}$$

$$\text{Firetube:}\quad \frac{11{,}000}{4{,}220} = 2.61\text{ lb. of coal per i.hp.-hr.}$$

The watertube high pressure design then would show a gain in power of 23 per cent and a gain in coal economy of 18.75 per cent. Figuring a five per cent increase in the weight of the water-filled boiler in the case of the watertube design, we would have a gain in power per pound of weight of 17 per cent. The reduction of this weight factor by refinements in design would be the measure of further gains in power. By the use of a tubular backhead in place of the staybolted head shown in the drawings, by the use of preheating tubes in the side walls in place of much of the firebrick, and by the elimination of other excess weight, this weight factor could be gradually lowered.

The use of high pressure also permits the use of smaller cylinders which, compounded, makes attractive the development of multi-cylinder design, resulting in a more uniform torque action and a consequent reduction in required adhesive weight.

The advantage of a high pressure design lies as much in the opportunities it affords for increased power within given dimensional limitations as it does in the possibility of greater coal economy. Which of these two would be most important, would vary with each case.

Bureau of locomotive inspection annual report

Substantial decrease is reported in the number of locomotives found defective

THE sixteenth annual report for the fiscal year ending June 30, 1927 of A. G. Pack, chief inspector of the Bureau of Locomotive Inspection to the Interstate Commerce Commission, highly commends those railroads who have applied low water alarms to locomotives for the contribution they have made to safety. As in previous reports, Mr. Pack has renewed his recommendations that the application of power grate shakers, horizontal hand holds, stirrups on cabs, and water columns with a water glass and gage cocks attached, and an additional water glass located on the left side of the boiler backhead, be made a requirement of the rules.

He has again stressed the need for giving closer attention to defects, the repairs of which are frequently considered unimportant. During the fiscal year ending June 30, 1927, 31 per cent of the locomotives inspected were found with defects or errors in inspection that should have been corrected before being placed in service. This, however, is a decrease of nine per cent from 1926 and is the best record that has been attained by the railroads since 1923. The percentage of locomotives inspected and found defective was 40 per cent in 1926, 46 in 1925, 53 in 1924 and 65 in 1923. This report also showed the lowest number of locomotives

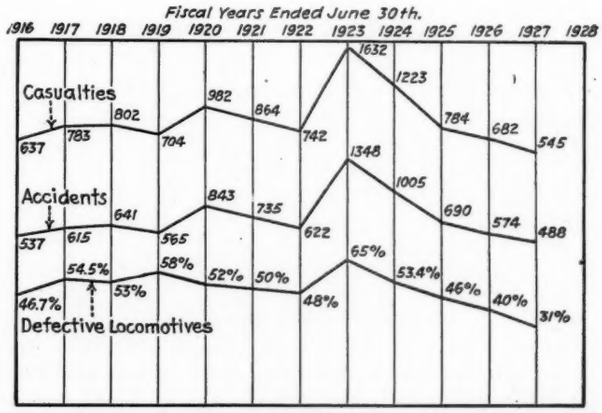
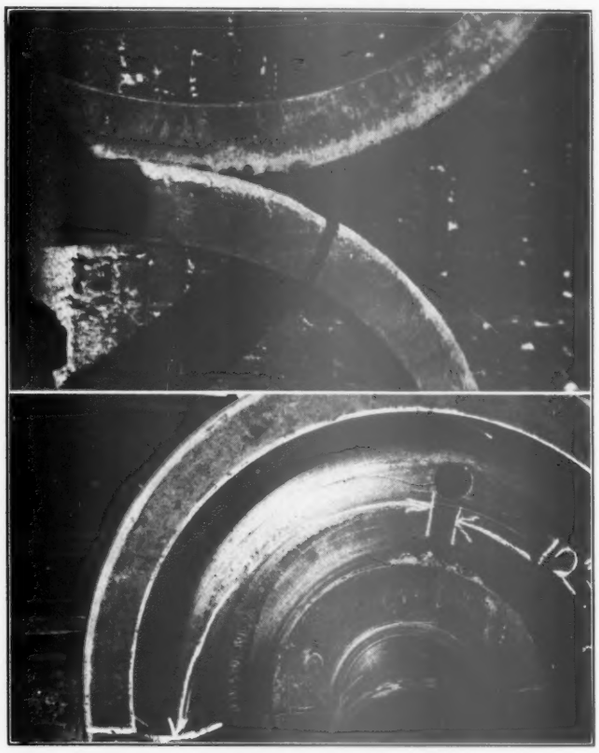


Chart showing the relation of defective locomotives to accidents and casualties resulting from locomotive failures

ordered out of service since 1923; a total of 2,539 being ordered out in 1927 as compared with 3,281 in 1926 and 7,075 in 1923. The report shows a decrease of 14.9 per cent in the number of accidents as compared with the previous year and a decrease in the number of injuries during the year of 21.6 per cent, but there is an increase of 27.3 per cent in the number of persons killed. The decrease in the total number of accidents reflects in a large measure the results of the substantial decrease in the percentage of locomotives found defective by the federal inspectors.

Defective squirt hoses were the cause of the greatest number of accidents during the year covered by the report. The 33 accidents reported as due to this cause, however, show a considerable improvement over the number of accidents accountable to the same defect in



Top—Two driving wheel tires that failed after the flanges had been trimmed with a cutting torch; Bottom—Cracks developed in a forged steel engine truck wheel due to the use of a cutting torch to burn the hole in the plate.

the report made in 1926, which was 51. Thirty accidents were due to defective reversing gears, 29 to defective grate shakers, 25 to defective brakes and brake rigging, 23 to defective flues and 22 to defective valve gears, eccentrics and rods. Nineteen accidents were due to crown sheet failures caused by low water and 12 accidents were due to defective water glasses and water glass fittings. Fifteen accidents were also caused by defective couplers.

The following is an abstract of Mr. Pack's report.

The chief inspector's report

Boiler explosions caused by crown-sheet failures continue to be the most prolific source of serious and fatal accidents with which we have to deal, 60.7 per cent of the fatalities during the year being attributed to this cause. There was a decrease of 48.7 per cent in the number of crown-sheet failures, but the average number of fatalities per accident increased, resulting in the same number of fatalities from this cause as occurred in the previous year. The fatalities per accident may be expected to increase with the increasing size of locomotives and the higher pressure carried in the boilers of modern locomotives. Our investigations indicate that material reduction in this class of accident and resulting casualties can be accomplished only by

Number of steam locomotives reported, inspected, found defective, and ordered from service

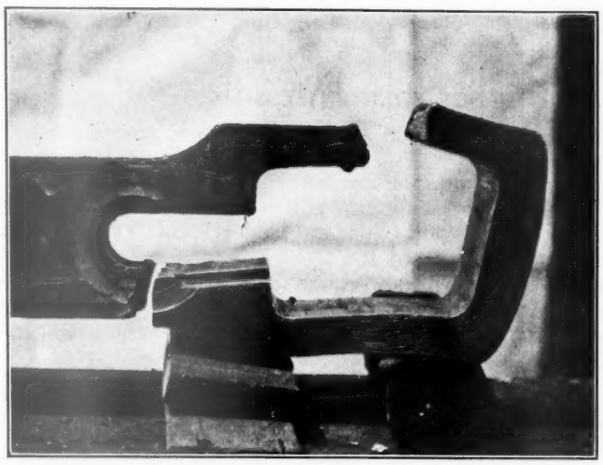
Parts defective, inoperative or missing, or in violation of rules	1927	1926	1925	1924
Air compressors	1,679	2,151	1,574	1,221
Arch tubes	127	204	198	272
Ash pans or mechanism	192	211	216	257
Axles	13	8	14	19
Blow-off cocks	650	280	825	965
Boiler checks	1,043	1,200	991	1,329
Boiler shell	1,422	1,888	1,597	2,103
Brake equipment	6,572	7,062	6,497	6,920
Cabs or cab windows	2,055	2,666	2,541	1,627
Cab aprons or decks	1,086	1,307	1,165	1,293
Cab cards	575	696	665	758
Coupling or uncoupling devices	289	394	447	398
Crossheads, guides, pistons, or piston rods	2,602	3,018	2,922	3,577
Crown bolts	235	334	283	418
Cylinders, saddles, or steam chests	4,526	5,080	4,352	5,712
Cylinder cocks or rigging	1,634	1,904	1,801	2,376
Domes or dome caps	388	463	371	494
Draft gear	2,037	2,634	2,283	1,981
Draw gear	2,210	3,140	3,273	4,160
Driving boxes, shoes, wedges, pedestals, or braces	2,710	3,342	3,241	3,722
Fire-box sheets	796	1,129	1,152	1,471
Flues	465	556	524	698
Frames, tailpieces, or braces, locomotive	1,682	1,973	2,036	2,580
Frames, tender	264	373	391	414
Gages or gage fittings, air	721	886	694	626
Gages or gage fittings, steam	1,425	2,038	1,809	2,026
Gage cocks	2,024	3,068	3,081	3,835
Grate shakers	613	720	832	1,006
Handholds	2,285	3,100	2,831	2,241
Injectors, inoperative	84	78	70	94
Injectors and connections	7,188	8,303	8,064	9,985
Inspections or tests not made as required	8,889	10,646	10,436	9,740
Lateral motion	673	758	659	939
Lights, cab or classification	107	106	86	72
Lights, headlight	835	946	928	904
Lubricator or shields	746	883	704	565
Mud rings	1,073	1,458	1,384	1,901
Packing nuts	1,851	2,772	2,761	3,304
Packing, piston rod and valve stem	2,214	2,489	2,411	3,187
Pilot or pilot beams	507	638	832	967
Plugs or studs	740	1,087	849	1,026
Reversing gear	1,247	1,539	1,274	1,217
Rods, main or side, crank pins or collars	5,137	5,683	4,813	6,507
Safety valves	212	270	234	188
Sanders	1,268	1,769	2,004	1,806
Springs or spring rigging	5,956	6,826	5,532	6,335
Squirt hose	644	975	1,008	1,221
Staybolts	631	905	741	916
Staybolts, broken	2,373	3,582	3,745	5,320
Steam pipes	1,308	1,587	1,590	2,305
Steam valves	774	962	869	981
Steps	2,440	3,227	2,867	2,829
Tanks or tank valves	2,747	3,430	3,352	3,393
Telltale holes	377	487	451	620
Throttle or throttle rigging	2,233	2,618	2,403	2,868
Trucks, engine or trailing	2,363	2,860	2,966	3,425
Trucks, tender	4,114	4,929	5,372	5,977
Valve motion	1,568	1,576	1,250	1,269
Washout plugs	2,786	3,649	3,588	3,204
Water bars or combustion flues	25	44	19	18
Water glass, fittings, or shields	2,973	3,621	3,713	4,201
Wheels	2,119	2,243	2,148	2,996
Miscellaneous—Signal appliances, badge plates, brakes (hand)	1,486	1,702	1,510	1,342
Total number of defects	112,008	136,973	129,239	146,121
Locomotives reported	67,835	69,173	70,361	70,683
Locomotives inspected	97,227	90,475	72,279	67,507
Locomotives defective	29,995	36,354	32,989	36,098
Percentage inspected found defective	31	40	46	53
Locomotives ordered out of service	2,539	3,281	3,637	5,764

proper location and maintenance of water-level indicating appliances that will accurately register the water level in the boiler under all conditions of service, the use of the safest practicable fire box construction, especially within the area which may be exposed to overheating due to low water, and the application of a device that will give an audible alarm when the water level approaches the danger point.

In my fifteenth annual report attention was called to the danger resulting from the use of reduced body

staybolts having telltale holes which do not extend into the reduced section at least 5/8 in. Failure of this type of bolt usually occurs at or close to the fillet joining the body of the bolt and the enlarged ends. Telltale holes which do not extend into the bolts to or beyond the usual point of breakage can not perform the function for which they are intended and mislead inspectors who depend upon the telltale holes as a check of the results of the hammer test.

When applying reduced body staybolts, great care should be exercised to see that the bolts are of proper length so that the threads on the bolts engage the threads in the sheets for the full thickness of the sheets. If the bolts are too long, a full bearing for the threads



This main rod broke while the locomotive was hauling a passenger train at an estimated speed of from 35 to 40 m.p.h.

is not obtained in each sheet and part of the bolt will blow out when breakage occurs, usually with fatal results.

One hundred and forty-six applications were filed for extension of time for removal of flues, as provided in Rule 10. Our investigations disclosed that in eight of these cases the condition of the locomotives was such that no extension could properly be granted. Eleven were in such condition that the full extensions requested could not be authorized, but extensions for shorter periods of time were allowed. Twenty extensions were granted after defects disclosed by our investigations had been repaired. Eleven applications were canceled for various reasons. Ninety-six applications were granted for the full period requested.

In my former reports recommendations were made, in accordance with Section 7 of the act, as amended, for the application of automatic fire doors, power reverse gears, power grate shakers, horizontal handholds, stirrups on cabs, and water columns with water glass and gage cocks attached with an additional water glass

Laminated drawbar which had been overheated and had apparently been cracked through the end of the eye for some time—Drawbar and pins were overdue for inspection

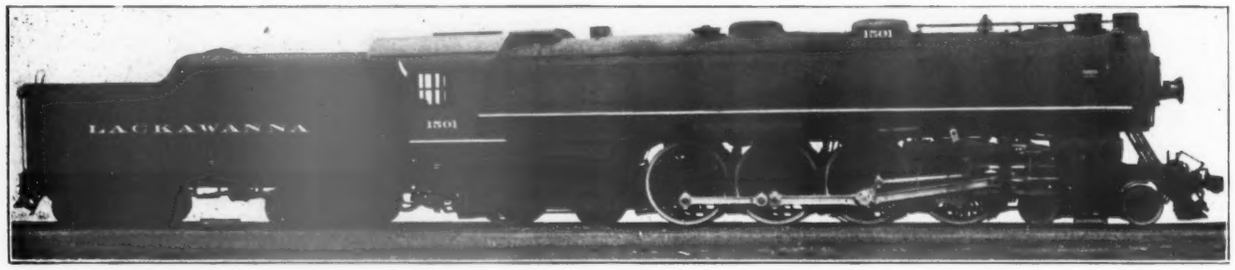
located on the left side or boiler back head, and reasons given therefor. While many of the carriers have recognized the value of these appliances and considerable progress has been made in the application thereof, the installations are not progressing as fast as could be desired to obtain the maximum degree of safety; therefore the recommendations are respectfully renewed and should be made a requirement of the rules.

Reference was made in my last annual report to the application of audible low-water alarms by many of the carriers in an effort to reduce the number of explosions caused by low water. A number of such devices have been developed, some of which appear to have proved themselves reliable from the viewpoint of the users.

A large percentage of the fatalities and many serious injuries would be prevented by the use of dependable low-water alarms, and the carriers who have applied these devices and those who assist in their further use and development are to be highly commended for the contribution to safety.

* * *

The Denver & Rio Grande Western 32 piece shopmen's band was organized two years ago and is supported by the shop force through their organization, The Association of Mechanical Crafts, Helpers and Apprentices—The band, in addition to playing for civic entertainments and radio broadcasting, plays three times a week at the Burnham shops during the lunch period



A 4-8-4 type built by the American Locomotive Company for the Delaware, Lackawanna & Western

Locomotive and motor car orders in 1927

Year's orders show trend toward higher steam pressures and increased use of auxiliaries

ONLY 734 locomotives were ordered for domestic service in the United States in 1927, as compared with 1,301 ordered in 1926. Orders for locomotives placed by railroads in Canada with builders in that country, nearly equaled those of a year ago, 1927 seeing 58 ordered as against 61 in 1926. Only in three instances since 1920, have Canadian orders exceeded those placed last year, these being orders for 68 placed in 1922, for 82 in 1923 and for 71 in 1924. On the other hand it will be noted from the chart that the decline in locomotives ordered last year in the United States was one of the lowest points reached in 27 years, there being only two lower points; namely, in 1921 when 239 locomotives were ordered and again in 1919 when only 214 were ordered. Locomotives ordered for use in foreign countries totaled only 54, less than a third of the number ordered in 1926. This figure together with the 734 ordered for service in the United States and the 58 for service in Canada, make a grand total of 846 locomotives ordered from builders in the two countries during 1927, according to figures compiled and published in the January 7, 1928, issue of the Railway Age.

Table I—Orders for locomotives since 1918

	Domestic	Canadian	Export	Total
1918	2,593	209	2,086	4,888
1919	214	58	989	1,170
1920	1,998	189	718	2,905
1921	239	35	546	820
1922	2,600	68	131	2,799
1923	1,944	82	116	2,142
1924	1,413	71	142	1,626
1925	1,055	10	209	1,274
1926	1,301	61	180	1,542
1927	734	58	54	846

Table I shows the number of locomotives ordered each year beginning with 1918 from locomotive builders in the United States and Canada. Table II shows the types of locomotives ordered in 1927. The same information for 1926 was shown in a similar table which was included in an article reviewing the locomotive and motor car orders for that year, which was published in the February, 1927, issue of the *Railway Mechanical Engineer*, page 85. In 1926, the preponderance of orders for switch engines was about even between the 0-6-0 and 0-8-0 types, there being 123 and 121 ordered respectively. The year 1927, however, shows a considerably larger proportion of 0-8-0 types there being 178 of them ordered as compared with only 46 of the six-wheel type.

Table II—Types of locomotives ordered in 1927

Type	Railroad	Industrial	Export	Total
0-4-0	5	5	3	13
0-6-0	46	10	0	56
0-8-0	179	1	0	179
0-10-0	4	0	0	4
2-6-0	4	0	4	8
2-6-2	0	2	1	3
2-8-0	9	0	4	13
2-8-2	71	3	15	89
2-8-4	82	0	0	82
2-10-0	10	0	0	10
2-10-2	17	1	0	18
2-10-4	47	0	0	47
Mallet	32	3	4	39
4-4-0	2	0	0	2
4-6-0	0	1	0	1
4-6-2	49	0	3	52
4-6-4	59	0	0	59
4-8-0	0	0	10	10
4-8-2	30	0	10	40
4-8-4	61	0	0	62
4-10-2	10	0	0	10
Geared	0	17	0	17
Miscellaneous	26	6	0	32
	743	49	54	846

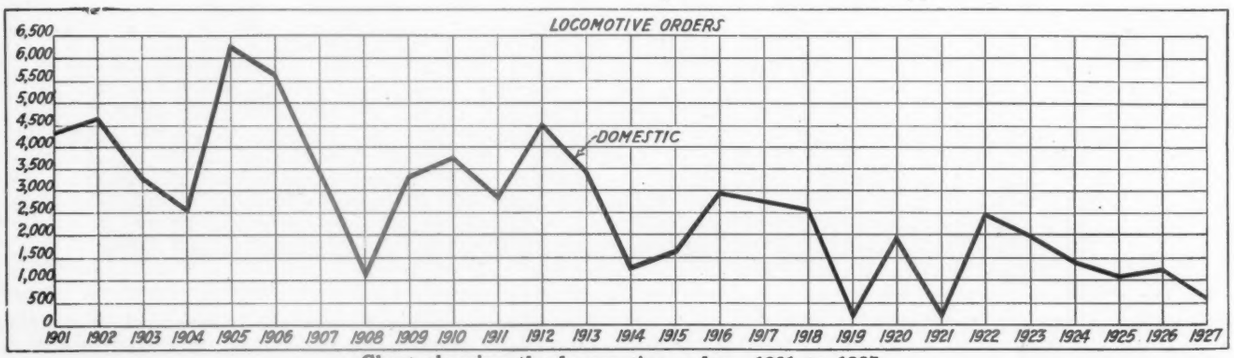


Chart showing the locomotive orders, 1901 to 1927

Extensive use of the four-wheel trailer truck

Comparison of the orders placed in 1927 by the railroads for 2-8-2 and 2-8-4 types, 2-10-2 and 2-10-4 types, 4-6-2 and 4-6-4, and 4-8-2 and 4-8-4 types shows an interesting trend toward the more extended use of the four-wheel trailer truck. This development is, undoubtedly, the feature of the year's orders and is indicative of the effort that is being made by both the railroads and builders to secure better boiler proportions and larger boiler capacity. The accomplishment of this objective means more horsepower and more horsepower means the maintenance of existing schedules with heavier trains in passenger service and the hauling of heavier trains or increases in speed, or combinations of both of these features in the case of freight service.

Table III—Orders for locomotives having two-wheel engine trucks and four-wheel trailer trucks

Road	Type	No.	Weight, lb.	Tractive force, lb.
Boston & Maine	2-8-4	20	385,000	69,400
Chicago & North Western	2-8-4	12	395,000	67,200
Chicago, Burlington & Quincy	2-10-4	12	512,110	90,000
Erie	2-8-4	25	443,000	71,000
	2-8-4	25	457,500	72,000
Texas & Pacific	2-10-4	35	448,000	84,600

Of the 1,301 locomotives ordered in 1926, only 107 had four-wheel trailer trucks. Of the 107 locomotives, 70 were 2-8-4 types, 15 were 4-6-4 and 22 were 4-8-4 types. No five-coupled locomotives with four-wheel trailers were ordered in 1926. The Texas & Pacific, however, ordered 35 locomotives of the 2-10-4 type last year which makes a total of 45 locomotives of that type ordered by that road since 1924. The Chicago, Burlington & Quincy also ordered 12 2-10-4 type locomotives in 1927, for use in freight service, (See Table III.)

Table IV—Orders for locomotives having four-wheel engine trucks and four-wheel trailer trucks

Road	Type	No.	Weight, lb.	Tractive force, lb.
Canadian National	4-8-4	40	385,590	56,800
Delaware, Lackawanna & Western	4-8-4	5	421,000	64,500
Grand Trunk Western	4-8-4	12	400,000	
Michigan Central	4-6-4	10	343,000	42,300
New York Central	4-6-4	24	348,500	42,300
	4-6-4	20	346,500	42,300
	4-6-4	5	349,500	42,300
Toledo, Peoria & Western	4-8-4	4	225,000	41,000

A total of 249 locomotives having four-wheel trailer trucks are shown in Tables III and IV. This is 33.5 per cent of the total number of locomotives ordered by the railroads in 1927. Of the 129 locomotives listed in Table III having two-wheel engine and four-wheel tailer trucks, 47 are of the 2-10-4 type and 82 of the 2-8-4 type. Table IV includes 121 locomotives, of which 59 are 4-6-4 types and 62 are 4-8-4.

The locomotive orders listed in Table III are primarily for freight service and those listed in Table IV are for passenger service. The four-wheel engine truck is still a distinguishing feature of the passenger locomotive. However, the 2-8-4 types ordered by the Boston & Maine and the 4-8-4 type locomotives ordered by the Canadian National, are for use in both freight and passenger service. The past few years have seen more railroads ordering locomotives that can be used in both services. This is due primarily to two developments; namely, the demand for faster freight train speeds, which in many cases approach passenger train schedules, and the development of the booster.

Tender and trailer-truck boosters

The majority of the locomotives in Tables III and IV are equipped with boosters. The tendency toward the use of the booster with the four-wheel trailing truck has been quite marked and in some instances where the boosters were not actually applied at the time the locomotives were built, provision has been made in the design of the trailer to permit their application later. The booster, providing additional tractive force when starting, permits the application of driving wheels of larger diameter than ordinarily used under freight locomotives.

Table VI—Orders for rail motor cars and trailers

	1922	1923	1924	1925	1926	1927
For service in the United States	51	77	120	149	142	180
For service in Canada	7	3	12	7	4	9
For export	1	22	..	34	32	12
Total	59	102	132	190	178	201
Motor cars	50	93	112	171	161	176
Trailers	9	9	20	19	17	25

The Canadian National 4-8-4 type locomotives built for both freight and passenger service have 73-in. diameter drivers. They develop a tractive force of 56,800 lb. Boosters have not been applied to these locomotives although the trailer truck has been designed to permit their application. Application of boosters to these locomotives will provide about 10,000 lb. additional tractive force at starting and give them a total tractive force rating of approximately 66,800 lb. This total compares quite favorably to 2-8-0, 2-8-2 and 2-8-4 type locomotives having 63-in. drivers but not equipped with boosters.

The increasing demands of terminal and hump yard service have induced a number of railroads to apply tender boosters or auxiliary locomotives to their switch engines. Both the Norfolk & Western and the Missouri Pacific had the tender trucks of one or more locomotives used in hump yard service removed and replaced with auxiliary locomotives to permit the utilization of the maximum proportion of the combined weight of the locomotive and tender for adhesion, in service where the slow speed does not ordinarily heavily tax the capacity of the boiler. The four 0-10-0 type locomotives ordered by the

Table VII—Comparison of rail motor car weights, U. S. and Canada

Weights	1925	1926	1927
25,000 lb. and under	6	7	..
Over 25,000 lb. to and including 50,000 lb	19	7	2
Over 50,000 lb. to and including 75,000 lb	74	2	4
Over 75,000 lb. to and including 100,000 lb	27	79	29
Over 100,000 lb	9	29	103
Unclassified	..	..	26

Table V—Orders placed in 1927 for oil-electric, Diesel, or gasoline locomotives

Purchaser	No.	Wheel arrangement	Type	Weight	Tractive force	Cylinders, No., dia. and stroke	Builders
Alaska	1	.....	Gasoline	48,000	.....	.....	Plymouth
American Rolling Mill Co.	1	.....	Oil-Electric	120,000	.....	.....	Ingersoll Rand-Amer.-Gen. Elec.
Anaconda Copper Mining Co.	1	0-4-0	Oil-Electric	47,000	.....	.....	Westinghouse-Baldwin
Boston & Maine	1	4-8-4	Diesel	314,000	50,000	6	Krupp (Ger.)
Chicago & North Western	1	.....	Oil-Electric	120,000	.....	.....	Ingersoll Rand-Amer.-Gen. Elec.
Erie	2	0-4-4-0	Oil-Electric	130,000	40,000	.....	Ingersoll Rand-Amer.-Gen. Elec.
Live Poultry Transit Co.	1	.....	Gasoline	65,000	.....	.....	.....
Long Island	1	0-8-0	Oil-Electric	200,000	60,000	.....	Ingersoll Rand-Amer.-Gen. Elec.
	1	0-8-0	Oil-Electric	200,000	60,000	.....	Westinghouse-Baldwin
N. Y., N. H. & Hartford	1	.....	Oil-Electric	40,000	.....	6-6x7	Fate-Root-Heath
Reading Company	1	.....	Oil-Electric	.....	.....	.....	Ingersoll Rand-Amer.-Gen. Elec.
Union Carbide Co.	1	.....	Oil-Electric	120,000	.....	.....	Ingersoll Rand-Amer.-Gen. Elec.

Duluth, Missabe & Northern in July, 1927, and delivered in December and January, are equipped with tender boosters, as well as a number of other switching locomotives built for railroads and industrial concerns, such as the Oliver Iron Mining Company, that operate extensive trackage.

Other trends in design

The past year has shown a trend toward higher steam pressures in locomotive boilers. Auxiliaries are being operated with superheated steam. Enlarged grate areas and greater firebox volumes are being used in increasing numbers, as are also feedwater heaters and exhaust steam injectors. The recent trend toward intensive capacity development in single-unit coupled wheelbase, has left comparatively little field for the compound articulated locomotive with its excessively large low pressure cylinders and higher back pressure horsepower and its difficult working stresses at other than low speeds.

The substitution of simple for the compound cylinders in the articulated wheelbase, however, has given the articulated type a new lease of life. The Denver & Rio Grande Western bought ten four-cylinder, simple articulated 2-8-8-2 type locomotives which were described in the October, 1927, *Railway Mechanical Engineer*. Another order for articulated types were four of the 2-8-8-2 type for the Southern. This type of locomotive continues to receive attention by roads where extremely large tractive force is required, where grades are long and heavy or where drag traffic predominates.

Long locomotive runs are continuing to have an effect toward increasing tender capacities, especially water capacity. The result of the efforts to save fuel by proper instruction of enginemen and the more extended use of economy devices, such as superheaters, feedwater heaters, stokers, back pressure gages, automatic firedoors, arches, syphons, etc., have made it unnecessary for the designer to enlarge bunker space but the tender capacity for water has been increased. The past year has also shown increased activity in and development of a modified boiler construction permitting more satisfactory service, not only for use with higher steam pressure, but with consideration of better water circulation, and the reduction of corrosion effects. Consideration is being actively given to the proper adaptation of condensing operation as well as the use of air preheaters.

Greater attention is being given to the use of alloy steels in locomotive construction, such as side rods, motion work, etc. The Canadian roads are each experimenting with boiler shells of special steels. Cast steel underframes for tenders are being more extensively used, with one-piece combined cast steel locomotive frames and cylinders have been built and, on one road a cast steel smokebox is in service.

Table VIII—Power plant capacity of rail motor cars in the United States and Canada

Horsepower	1925	1926	1927
100 or less	13	14	2
Over 100 to and including 125	5	7	..
Over 125 to and including 150	9	..	..
Over 150 to and including 175	20	1	..
Over 175 to and including 200	49	3	3
Over 200 to and including 250	36	65	43
Over 250 to and including 300	2	26	76
Over 300	2	10	16
Unclassified	..	..	24

Table IX—Number, type and weight of rail motor cars ordered in 1926 for service in the United States and Canada

Builder	Type of power plant	No. motor cars	Horsepower	Nominal weight, lb.
American Car & Foundry	Gas-electric	1	275	115,000
	Gas-electric	1	550	139,000
Am. Car & Fdry.-J. G. Brill	Gas-electric	1	550	137,000
	Gas-electric	11	275	106,000
Bethlehem Steel	Gas-electric	1	440	132,000
J. G. Brill Co	Gas-electric	30	250	92,000
	Gas-electric	18	250	114,000
	Gas-electric	1	275	110,000
	Gas-electric	1	190	60,000
	Gasoline	2	190	60,000
	Gasoline	1	70	30,000
	Gasoline	1	68	36,000
	Gas-electric	1	550	135,000
Brill-Westinghouse	Gas-electric	1	275	.....
Canadian Car & Fdry	Oil-electric	5	300	141,000
	Gas-electric	1	275	85,000
East Broadtop *	Gas-electric	1	250	94,000
Electro-Motive	Gas-electric	30	275	100,000
	Gas-electric	5	550	.....
	Gas-electric	2	440	128,000
	Gas-electric	1	220	98,000
Osgood Bradley	Gas-electric	3	440	127,000
Pullman	Gas-electric	29	275	110,000
Railway Motors Corp	Gas-electric	1	200	76,000
Standard Steel	Gas-electric	1	440	132,000
	Gas-electric	12	300	123,000
Oahu Railway & Land Co.	Gasoline	2	208	62,000
Total		164		

* Company built.

Important locomotive orders in 1927

Of the large orders for steam locomotives placed during the past year, the following railroads ordered 15 or more locomotives: The Boston and Maine ordered 10 0-8-0 and 20 2-8-4 types; the Central of New Jersey ordered five 4-6-2 and 10 0-8-0 types; the Chicago & North Western, 12 2-8-4 and eight 0-8-0 types; the Chicago, Burlington & Quincy ordered 12 2-10-4, two 0-6-0 and three 0-8-0 types and the Delaware, Lackawanna & Western, 10 4-8-2 and five 4-8-4 types. The Erie placed a large order for 50 2-8-4 and 30 0-8-0 type locomotives, in addition it also bought 15 tenders. The Grand Trunk Western ordered 12 4-8-4 and 20 0-8-0 types, the Illinois Central, 15 0-8-0 type; the Missouri Pacific, 13 0-6-0 and five 2-8-2 types; the New York Central, 49 of the 4-6-4 type and the Pennsylvania, 25 of the 4-6-2 type. The Seaboard Air Line ordered 25 six-wheel switchers. The Southern was the largest buyer of locomotives during the year, placing orders for 55 2-8-2, five 4-6-2, eight 2-8-8-2 and eight 4-8-2 types. The Southern Pacific ordered also eight 4-8-2 types and 10 of the 4-10-2. The Texas & Pacific ordered 35 more 2-10-4 types and five 0-8-0. The Canadian National was the largest purchaser of locomotives in Canada placing orders for 40 4-8-4 and 10 0-8-0 types. The passenger locomotives were built by Canadian locomotive builders while the switch engines were built in the shops of the railroad.

Diesel locomotives

A total of 13 oil-electric or gasoline locomotives were ordered for domestic service in 1927. This is two less than the number ordered during the preceding year. A list of these locomotives ordered in 1927, is shown in Table V. Seven of these units have Ingersoll-Rand oil engines, two were built by Westinghouse-Baldwin, and one each by Plymouth and the Fate-Root-Heath Company.

The order placed with Fried. Krupp, Germany, by the Boston & Maine for a 50,000-lb. tractive force, Diesel-geared locomotive has attracted considerable attention. This is the heaviest locomotive of this class ordered during the year, having a total weight of 314,000 lb. The next heaviest are the two oil-electric locomotives ordered by the Long Island which weigh 200,000 lb. each. The progress of the Diesel locomotive is still in the development stage. Its possibilities for terminal and yard service, especially in localities where ordinances against smoke are in force, are appealing to many railroads.

Orders for rail motor cars increase in 1927

Except for 1926, the number of orders for rail motor cars and trailers have increased each year since 1922, as

shown in Table VI. During 1927, orders were placed for a total of 201 internal combustion engine propelled motor cars and trailers. Of these, 180 were for service in the United States, of which 157 are motor cars and 24 are trailers. Table VI shows a comparison of the orders for this type of equipment since 1922, when orders for rail motor cars and trailers were first reported in the Railway Age. Attention should be called to the orders in 1926 which were reported in the February, 1927, issue of the *Railway Mechanical Engineer*, page 87. Owing to a duplication which occurred in tabulating the orders placed in 1926 by the Lehigh Valley, the totals for that year were too large by nine motor cars and seven trailers.

The data pertaining to th ehorsepower of the motor and the weight of the car is incomplete and for that reason, a comparison of car weights and power plant capacity shown in Tables VII and VIII, must be based on considerably less than the total number of cars ordered last year. It is evident, however, from the data contained in these tables that the same tendency is still shown in a marked degree and that a considerable proportion of the motor cars ordered during 1927 weighed over 100,000 lb., and have power plants in the 250 hp. to 30 hp. group. An increase is also shown in the number of cars having power plants over 300 hp., most of which are the double power plant type, developed from 400 to 550 hp.

This tendency away from the smaller and lighter cars has been accompanied by a material decrease in the number of cars with the gear shift type of transmission. All but six of the cars shown in Table IX are equipped with electric transmission. The past year has seen a considerable reduction in the weight of the engine and generator of Diesel-electric power units suitable for rail motor cars. A number of cars built in 1927 have a weight for the combined engine and generator of about 26 lb. per horse power.

A feature in the developments during 1927, in the motor car field is the high pressure steam driven motor car developed in the laboratories of the International Harvester Company. The use of high steam pressures (in this car they vary from 550 to 600 lb. in the working range) in motors especially designed for such pressures at relatively high speeds, opens up a new field for the use of steam which is likely to lead to a number of interesting developments in the next few years.

Diesel engines for locomotives*

A proposal to design the cylinders of the steam locomotive to be used either as steam or Diesel or as both simultaneously

By R. Hildebrand

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Part I

The principal objection to a steam locomotive is its very low efficiency. A switch engine operates with about two per cent, and the average main-line locomotives with 6 to 8 per cent total efficiency. Thus, from 92 to 98 per cent of the total coal burned is lost.

The Diesel engine, on the other hand, is the most economical prime mover. It has a thermal efficiency of about 33 per cent, but it is an engine which cannot be started under full load, and which cannot carry a heavy overload without encountering excessively high temperatures and pressures inside of its working cylinders. Lacking sufficient flexibility, it has not yet become practicable to drive the axles *directly* by Diesel power.

The total weight of the locomotive should not overstep certain limits, because the existing road beds, bridges, etc. cannot stand an excessive load. In order that the total weight of the locomotive may remain within customary limits, which are about 160 lb. per hp., its engine plus its drive should not exceed a certain weight. As all indirect drives are heavy, particularly the electric type, the engine proper should not weigh more than 50 to 60 lb. per b.hp. This weight is too light for the heavy-duty service which is required by the railroads.

The term "heavy duty" means that the engine can be used for a greater length of time without being completely overhauled. This is impossible with light-weight engines, as the designer is forced to use high rotary speed, and to push the working cylinders as closely together as practical. This results in high cylinder wear and short bearings, and consequently high bearing wear.

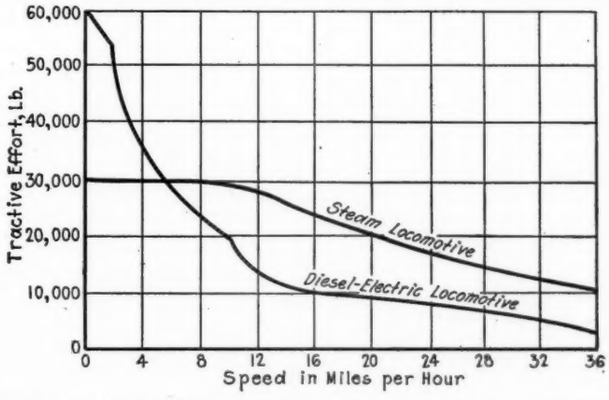


Fig. 1.—Comparison of the tractive force curves for Diesel-electric and steam locomotives.

* Abstract of a paper contributed by the Oil and Gas Power Division for presentation at the annual winter meeting of the American Society of Mechanical Engineers, December 5 to 8, 1927.

The high wear and tear of engines of this kind is sufficiently proved by submarine engines, which also weigh 50 to 60 lb. per b. hp. For submarines, however, the initial and maintenance costs are of secondary importance, while the deciding factor for railroads is first of

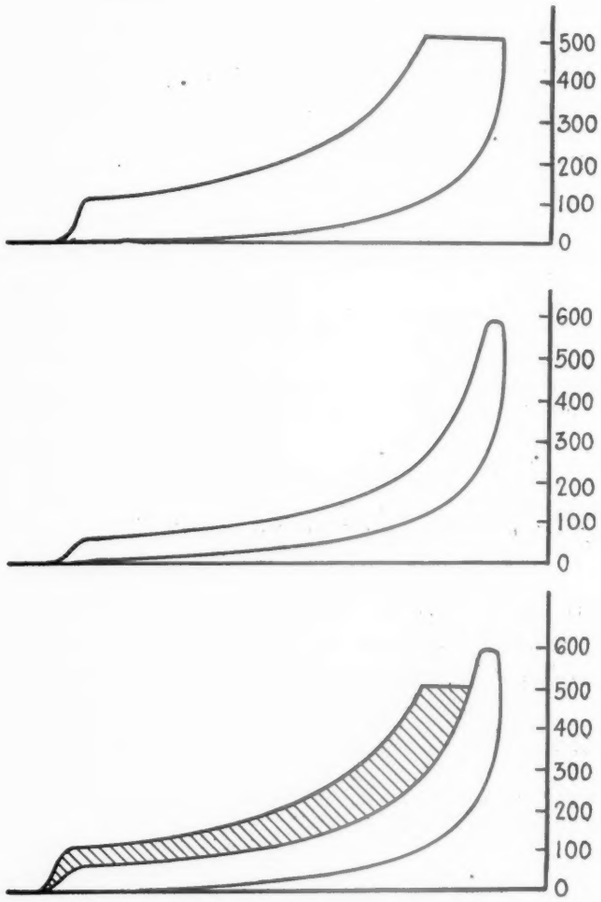


Fig. 2—Theoretical indicator cards for the D-H locomotive. Top—Starting conditions; Center—Operating under full Diesel power; Bottom—Using both Diesel and steam power.

all the commercial result. For railroads, the high initial and maintenance costs of the present Diesel-electric locomotive, or other Diesel locomotives with indirect drive, will be a great handicap.

Furthermore, the indirect drive, whether it is electric, hydraulic, or gaseous, has a low mechanical efficiency. For instance, the electric transmission has about 65 to 85 per cent mechanical efficiency, depending on the load and speed.

Also undesirable are the peculiar speed-tractive force characteristics of locomotives using Diesels as prime movers which drive by means of any of the indirect power transmissions. These characteristics differ much from those obtained with steam locomotives.

This is illustrated in Fig. 1, which shows the tractive force curves for Diesel-electric and steam locomotives. The former has a very favorable tractive force during starting, but it drops off very rapidly when the speed increases. Thus the Diesel-electric locomotive is well adapted for switching because it can quickly accelerate a heavy train. However, for main-line engines, the steam locomotive furnishes a much more desirable tractive force at higher speeds.

The above-mentioned strong and weak points of the present Diesel locomotives are fundamental. These being facts, it appears that the present Diesel, in spite of its very desirable thermal efficiency, is a prime mover which leaves much to be desired for main-line service.

The Diesel-steam locomotive

What the author proposes is not to abandon but to improve the steam locomotive with its direct drive by changing its working cylinders so that they may be used either as a Diesel or as a steam engine, or simultaneously as a Diesel-steam engine. The combination of the Diesel and steam power could be called the Diesel-steam engine. However, to distinguish the engine which the author proposes from the existing well-known "Still" engine, which is also a Diesel-steam engine, the author's engine will be called hereafter the D-H (Diesel-Hildebrand) engine or locomotive.

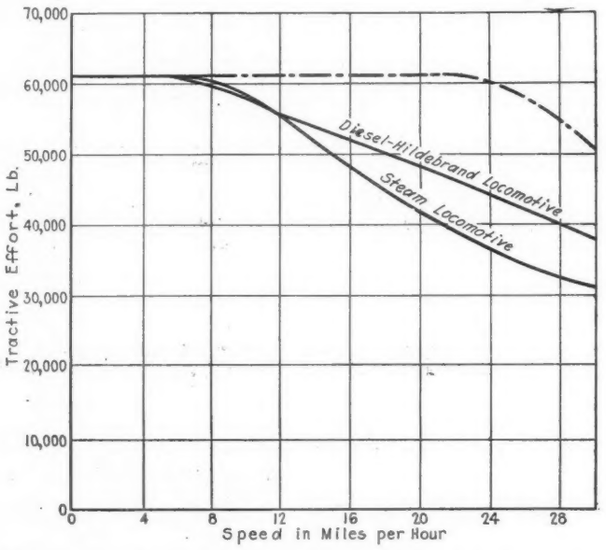


Fig. 3—Tractive force of a 2-8-2 type steam locomotive compared to the D-H locomotive using combined Diesel and steam power.

During starting, only steam will be used. Fig. 2 shows a starting card which is identical with that of a uniflow steam engine. Starting with steam, the D-H locomotive will have the same powerful starting ability as the existing steam locomotive.

When the engine runs with normal speed and *average* load, Diesel power only will move the train and its indicator card will resemble that of the center card in Fig. 2. The locomotive while using Diesel power only will operate with a thermal efficiency which is in the neighborhood of 33 per cent and with a mechanical efficiency of about 84 per cent, as the axles are directly driven, and the engine will be of the double-acting two-cycle type. These are efficiencies which none of the existing Diesel locomotives possess.

While climbing steep grades, the D-H locomotive will use Diesel plus steam power. When steam is used in addition to Diesel power the steam will be admitted into the cylinders after the combustion of fuel is substantially completed, and after the gases are expanded to a pressure which about equals the steam pressure. The indicator card while using Diesel and steam power will appear similar to that shown in the lower card in Fig. 2. The cut-off chosen in this card admits just sufficient

steam so that the auxiliary steam power (shaded area) increases the Diesel power by 100 per cent.

The admission of steam into the power cylinders will begin when the load begins to exceed the *average*, i.e., when the normal Diesel rating of the engine is reached and overstepped. The steam will then carry the load above that which can be carried by Diesel power. Thus the Diesel power will be used to its fullest extent, and the cut-off of the steam will be chosen to carry the overload.

As the power cylinders will be dimensioned for the *average* power demand, the D-H engine will have the highest possible thermal efficiency while running under the average load. This thermal efficiency, at the *average* power demand, will be decidedly higher than that now obtained with any Diesel locomotive because their Diesel engines must be dimensioned to suit the maximum power demand, which is undesirably large for the average load.

Admission of the steam into the Diesel cylinder, and mixing it with the hot gases therein, will prevent dangerous overheating of the power cylinders because the steam, even if superheated, will have a cooling effect on the hot combustion chambers. The higher the load, the greater will be the quantity of steam admitted, and the more effective will be the internal cooling of the combustion chamber.

A thermodynamic calculation shows that the steam consumption of the D-H locomotive will be at least as low as that of the compound steam engine when it operates at its most favorable cut-off. This will be the case while the D-H locomotive operates at its most unfavorable cut-off, i.e., when it carries a 100 per cent overload over its Diesel rating.

The explanation for this favorable steam consumption is to be found in the fact that no steam whatever will condense when it enters the power cylinders. On the contrary, as stated, the steam will superheat when it mixes with the hot Diesel gases. The fact is that the steam will still be superheated when it is exhausted into the atmosphere.

From the above it appears, when comparing the D-H locomotive with a locomotive having large cylinders of sufficient capacity to meet the maximum demand by Diesel power, that the thermal efficiency of the D-H locomotive is higher at loads up to the average and lower at loads above the average. Thus, it can be expected that the thermal efficiency of the two compared locomotives is about at par. However, the D-H locomotive will have a much higher mechanical efficiency and also the advantage that it eliminates the indirect drive, and is well adapted for main-line service.

Comparison of Diesel-steam and Still locomotives

Here it may be of interest to compare the D-H locomotive with the Still locomotive. The latter type of locomotive is under construction in England and France while stationary Still engines have been in actual service for some time and have proved satisfactory. The Diesel-steam locomotive of the Still type drives the axles directly by means of one set of reduction gears, eliminating the disadvantage of the indirect drive. This is a distinct feature of the Still locomotive, and its results will be watched with keen interest by the railroads.

It will be remembered that the Still is a double-acting engine. Its head end is used exclusively for developing Diesel power and its crank end is used for developing steam power. Therefore the Still is a single-acting Diesel and a single acting steam engine. The Diesel economy is confined to the head end, and the overload-carrying capacity is confined to the crank end. The D-H engine is also double-acting, but it develops Diesel power (high efficiency) and steam power (high overload-carrying capacity) on both sides of the piston. Thus the D-H locomotive with the same cylinder volume as the Still locomotive will have about twice the starting and overload-carrying capacity. The D-H locomotive will therefore adapt itself better to the requirements of the railroads than the Still locomotive.

Furthermore, the steam in the Still engine expands in the cool and unsuited crank ends of the working cylinders. With the exception of starting or climbing steep grades, the steam ends of the working cylinders of the Still engine will use short cut-offs which, in connection with cool cylinders, are bound to result in a high steam consumption per steam horsepower-hour. In the D-H locomotive the steam expands under the most favorable conditions, i.e., in hot Diesel cylinders. In consequence, its steam consumption is exceptionally favorable, and it decreases with the decrease of cut-off. From this it appears that the steam economy of the D-H locomotive will also be higher than that of the Still locomotive.

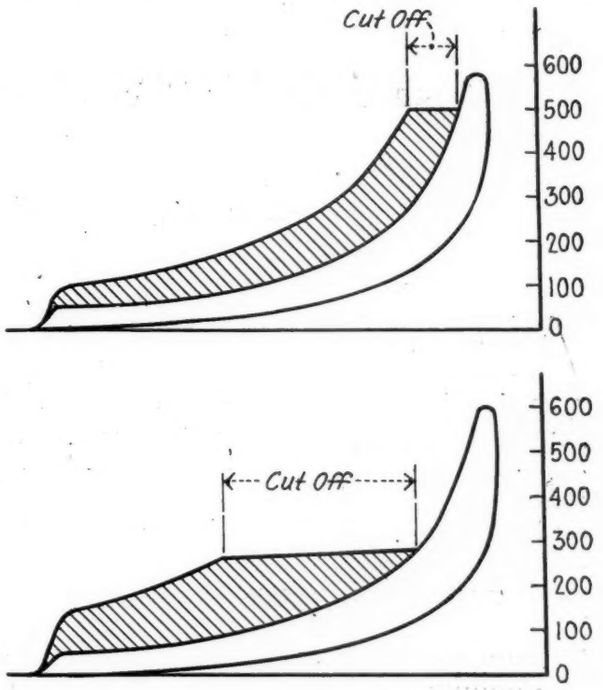


Fig. 4—Indicator cards showing the advantage of high pressure boilers for the D-H locomotive

It will also be of interest to compare the D-H locomotive with the existing steam engine. We shall assume a D-H locomotive of 1,400 Diesel hp. at a speed of 24 m.p.h.; and we shall assume a freight steam locomotive of the 2-8-2 type with 27-in. by 32 in. cylinders, and a maximum tractive force of about 60,000 lb. We shall further assume that the boiler capacity of the D-H locomotive is 60 per cent of the boiler capacity of the freight steam engine. Fig. 3 shows the tractive force curves of the 2-8-2 type locomotive and that of the D-H locomotive when using combined Diesel and steam power. Fig. 3 further shows, by a dash-and-dot line, the tractive force which the D-H locomotive would have, provided its boilers capacity equaled the boiler capacity of the steam freight locomotive.

(To be concluded next month)

Car orders placed during 1927

Application of roller bearings feature passenger car orders —Tendency to use other than A. R. A. standard trucks in freight car construction

A TOTAL of 72,006 freight cars were ordered in 1927 according to statistics published in the January 7, 1928, issue of the Railway Age, or 4,977 more than in 1926. The freight cars ordered by Canadian railroads for service in Canada amounted to 2,133 or about 500 more than were ordered in 1926. This is the highest total for Canadian orders since 1923. A total of 646 freight cars were ordered for service in foreign countries, making a grand total of 74,785 freight cars ordered from the car manufacturers in this country and Canada. Table I shows the number of freight cars ordered for domestic, Canadian and export service since 1918. The number of freight cars ordered since 1901 is also shown in one of the charts.

Table I—Orders for freight cars since 1918

Year	Domestic	Canadian	Export	Total
1918	114,113	9,657	53,547	177,317
1919	22,062	3,837	3,994	29,893
1920	84,207	12,406	9,056	105,669
1921	23,346	30	4,982	28,358
1922	180,154	746	1,072	181,972
1923	94,471	8,685	396	105,552
1924	143,728	1,867	4,017	149,612
1925	92,816	642	2,138	95,596
1926	67,029	1,495	1,971	70,495
1927	72,006	2,133	646	74,785

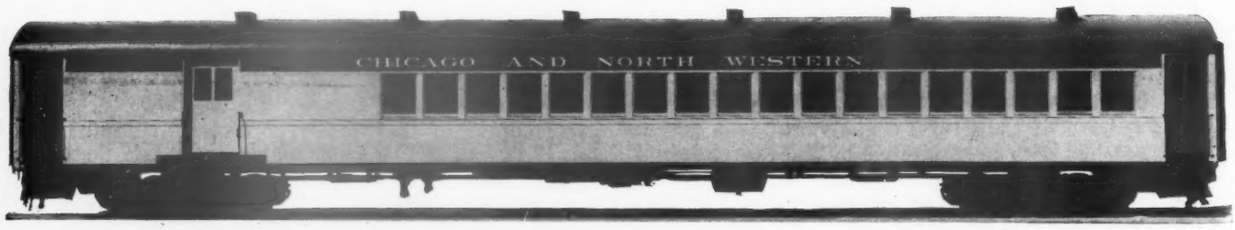
Passenger car orders for domestic use totaled 1,612 in 1927, or about 250 cars behind the orders placed in 1926 when the total was 1,868. Railroads in Canada ordered 143 passenger cars for service in that country as compared with 236 ordered in 1926. Orders for passenger cars for export amounted to 48 as contrasted to 58 ordered in 1926 and 76 in 1925. Orders for passenger cars for service in the United States, Canada and for export are shown in Table II. Also the passenger cars ordered for domestic service since 1901 are shown in one of the charts. The grand total of passenger cars ordered in 1927 from builders in this country and in Canada was 1,803.

Table II—Orders for passenger cars since 1918

Year	Domestic	Canadian	Export	Total
1918	9	22	26	57
1919	292	347	143	782
1920	1,781	275	38	2,094
1921	246	91	155	492
1922	2,382	87	19	2,488
1923	2,214	263	6	2,483
1924	2,554	100	25	2,679
1925	2,191	50	76	2,317
1926	1,868	236	58	2,162
1927	1,612	143	48	1,803

More gondola cars than hopper cars ordered in 1927

Table III shows the types of freight cars ordered in 1927 for use in the United States and Canada. Of

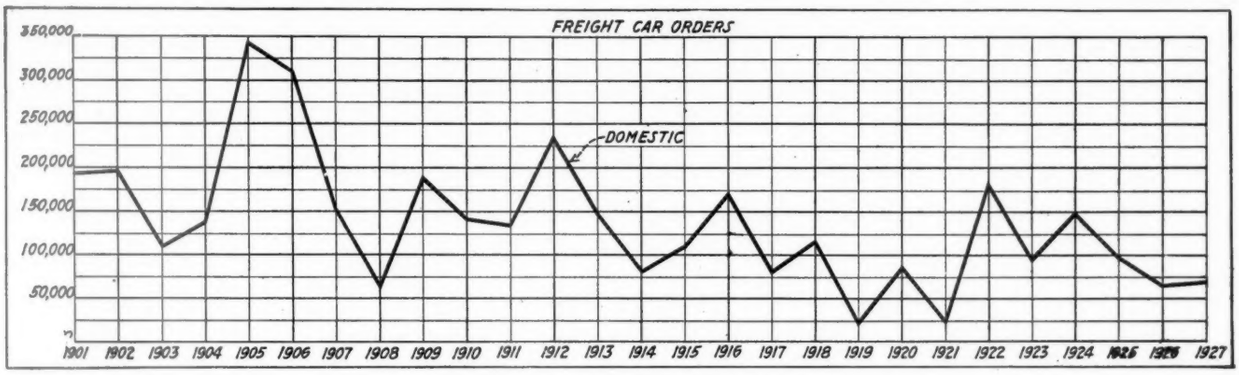


Car equipped with roller bearings built by the American Car & Foundry Company

the total of 74,139 freight cars ordered for service in the two countries, 21,296 or 28.7 per cent were bo xcars, 17,904 or 24.2 per cent were gondola and 9,007 or 12.15 per cent were hopper. These figures are somewhat different than those given in a similar table which was included in an article reviewing the freight and passenger car orders for 1926, published in the February, 1927, issue of the *Railway Mechanical Engineer*, page 108. A total of 68,524 freight cars were ordered during 1926 for service in the United States and Canada of which 16,055 or 23.4 per cent were box cars, only 8,849 or 12.9 per cent were gondola and 13,033 or 19 per cent were hopper. The year 1926 saw 10,489 refrigerator cars ordered as compared to only 7,134 for 1927.

A.R.A. standardization program influencing freight car design

The American Railway Association, Mechanical Division, has added the general design of a standard stock car built up on the single sheathed box car frame to its standard single and double wood sheathed box cars. The Committee on Car Construction is now working on the details of the design of the standard stock car. This committee also has under way the development of the general design for standard automobile cars and for 50 and 70-ton self-clearing hopper cars.



Freight car orders, 1901 to 1927

Cars built

The total of freight cars built in 1927 (see Table IV) for service in the United States, was 63,390 as compared to 88,862 in 1926. The number built in 1927 for domestic use was about on a par with the number built in 1920 and was below that of any year since, except 1921, when only 40,292 were built and 1904 when 60,955 were built.

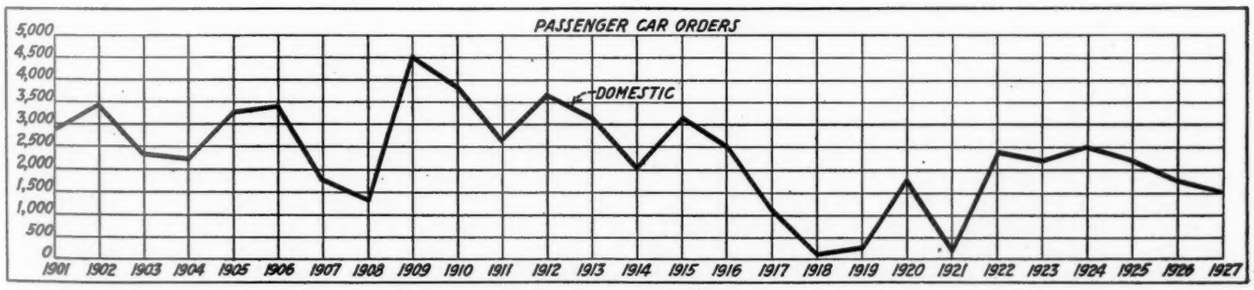
General design of the two latter cars have already been presented to the association, but the completion of the design since the final adoption of the height of 10 ft. 8 in., has not yet been effected. The essential features of the design, however, have already been incorporated in new cars on a number of railroads. One of these cars is shown in one of the illustrations. The Committee on Car Construction also has under consideration the development of a steel frame refrigerator car designed to be built up around the A. R. A. box car

Table III—Types of freight cars ordered in 1927 for use in the United States and Canada

Type	Number	Per cent
F.—Flat and logging	2,904	3.9
G.—Gondola	17,904	24.2
H.—Hopper	9,007	12.2
R.—Refrigerator	7,134	9.6
S.—Stock and poultry	2,191	2.9
T.—Tank	3,894	5.3
X.—Box	21,296	28.7
Automobile	5,800	7.8
Ballast, dump and ore	2,168	2.9
Not classified	954	1.3
N.—Caboose	887	1.2
Total	74,139	100.0

Table IV—Freight cars built each year since 1913

	United States			Canadian			
Year	Domestic	Foreign	Total	Domestic	Foreign	Total	Grand total
1913	176,049	9,618	185,667	22,017	....	22,017	207,684
1914	97,626	462	98,088	6,453	....	6,453	104,451
1915	58,226	11,916	70,142	1,758	2,212	3,970	74,112
1916	111,516	17,905	129,421	....	....	5,580	135,001
1917	115,705	23,938	139,643	3,658	8,100	11,758	151,401
1918	67,063	40,981	108,044	14,704	1,960	16,664	124,708
1919	94,981	61,783	156,764	6,391	30	6,421	163,185
1920	60,955	14,480	75,435	....	....	....	....
1921	40,292	6,412	46,704	8,404	745	9,149	55,853
1922	66,289	1,126	67,415	458	100	558	67,973
1923	175,748	2,418	178,166	....	....	....	....
1924	113,761	1,141	114,902	1,721	....	1,721	116,623
1925	105,935	3,010	108,945	....	....	....	....
1926	88,862	2,771	91,633	1,645	....	1,645	93,278
1927	63,390	1,087	64,477	2,851	....	2,851	67,328



Passenger car orders, 1901 to 1927

underframe and to use trucks of standard A. R. A. design.

In addition to the work being done by the Mechanical Division, A. R. A., the past year has seen the progress of a number of developments that may have an important effect on future freight car design. One railroad is experimenting with a solid cast steel underframe for freight cars. A number of improvements are also being made in refrigerator cars which involve the use of the "silica gel" progress and "dry ice" or solid CO_2. Quite a number of roads have ordered automobile cars with 12-ft. side doors to meet an urgent demand from automobile manufacturers for cars with wide side doors, so that easier loading of completed automobiles is afforded.

Table V—Passenger cars built each year since 1913

	United States			Canadian			Grand
Year	Domestic	Foreign	Total	Domestic	Foreign	Total	total
1913	2,559	220	2,779	517	....	517	3,296
1914	3,310	56	3,366	325	....	325	3,691
1915	1,852	14	1,866	83	....	83	1,949
1916	1,732	70	1,802	37	....	37	1,839
1917	1,924	31	1,955	45	....	45	2,000
1918	1,480	92	1,572	1	....	1	1,503
1919	306	85	391	160	....	160	551
1920	1,272	168	1,440	....	....	....	....
1921	1,275	39	1,314	361	....	361	1,675
1922	676	144	820	71	....	71	891
1923	1,507	29	1,536	....	....	....	....
1924	2,150	63	2,213	167	....	167	2,380
1925	2,363	50	2,413	....	....	....	....
1926	2,184	102	2,286	285	....	285	2 571
1927	1,785	50	1,835	126	....	126	1,961

There appears to be a tendency on the part of a number of railroads to depart from the A. R. A. standard design of freight car truck. The service of standard designs, with the difficulty which they offer in securing sufficient spring capacity for the higher capacity cars, has placed the matter of truck design very much in a state of flux. The Car Construction Committee is working with the spring manufacturers to bring about the development of springs possessing qualities sufficiently superior to those of the present standard type, so that satisfactory service may be assumed with the present standard type of bolster opening.

In the meantime, several types of trucks have been brought out and others are in the process of development in the design of which present standards have been departed from in order that designs more in keeping with the present service requirements may be produced. Among these are the Dalman truck and the Symington "double truss" side frame design, the latter of which has only reached a state of commercial development during the past year.

Table VI—Types of passenger equipment ordered for use in the United States and Canada

Type	1924	1925	1926	1927
Coach, combination passenger, etc.	952	650	432	760
Multiple unit coaches and trailers	....	82	237	52
Sleeping, parlor, chair, etc.	543	535	542	238
Dining	133	112	111	111
Baggage, express, mail	555	739	435	422
Express refrigerator	410	10	125	2
Milk	12	80	60	45
Horse	34	16	95	17
Private, business, miscellaneous	15	17	67	108
Total	2,654	2,241	2,104	1,755

Passenger cars

The number of passenger cars built for use in the United States in 1927 was 1,785. This total was less than the number built in each of the last four years, 2,184 being constructed in 1926, 2,363 in 1925 and 2,150 in 1924. The number of passenger cars built each year in the United States and Canada for domestic and foreign service since 1913, is shown in Table V.

Table VI shows the types of passenger equipment ordered for use in the United States and Canada for 1924, 1925, 1926 and 1927. It will be noted that the total of 1,755 is considerably less than the totals for the preceding three years. On the other hand, the number of coaches and combination passenger cars ordered in 1927, is considerably larger than the number ordered in 1926 and 1925, there being 760 of this type of equipment ordered as compared with 432 and 650, respectively for the two preceding years. The year 1924 shows a total of 952 coaches and combination passenger cars, the largest number for the four years shown.

Orders for sleeping, parlor, chair cars and coaches for through passenger train service make a strong showing as in the preceding three years. A total of 238 cars of this type were ordered in 1927, which is 13.6 per cent of the number of cars ordered that year. This is about 10 per cent less than the ratio for this type of equipment to the total figures for 1926, 1925 or 1924.

In this connection, it is interesting to note that 108 of the 238 sleeping, parlor, chair cars, etc., were orders placed by the Pullman Company with the Pullman Car & Manufacturing Corporation for cars for Pullman use. This is in contrast with 481 cars of this type reported for that company in 1926 and for 425, the average yearly purchases reported by Pullman for the five years, 1922 to 1926, inclusive. Had Pullman orders in 1927 approached the number in 1926, total orders for passenger cars for domestic use in 1927 would have more than equalled those placed in 1926.

The largest order placed in 1927 was that of the New York Central for 195 cars. Next was the Long Island with 127, the Chicago & North Western with 120, then the Chicago, Burlington & Quincy with 118, followed by the Baltimore & Ohio with 100.

Continuance of trend toward special interior arrangements

Although no change of major importance in the trend of passenger car design or construction has developed during the past year, there has been evident a continuation of the tendency toward special interior arrangements, especially of club and lounging cars for use on long distance trains, and towards a change from the clere-story type of roof construction to the turtle back roof and modifications thereof. The building of passenger cars with interior arrangements designed to meet special traffic demands, has been thoroughly established for some years. This has been accompanied by marked individuality in the treatment of interior decorations, hangings and furnishings. In recently built dining cars close attention to the arrangement of the kitchen and serving facilities has led to a number of novel arrangements. Electric refrigerating equipment and mechanical dish washers are also beginning to find their place in the dining car kitchen.

Interest in the application of roller bearing journals to passenger cars showed a marked increase during the past year. At the present time about 500 roller bearing equipped passenger cars are now in service. Quite a number of railroads have experimental installations on one or two cars, but the majority seem disposed to watch the results obtained from the roller bearing equipment in service rather than to proceed with any wholesale experimenting themselves.

Cleaning passenger car equipment

Methods of cleaning and caring for cars described in paper read before Southwest Master Car Builders' and Supervisors' Association

By F. W. Stevens

General car foreman, Missouri-Kansas-Texas, San Antonio, Texas

ONE very important item in connection with the operation of passenger trains is to have all cars in presentable condition, both inside and outside. This importance is increasing daily due to the demands of the traveling public, which is brought about, possibly, by the public being more fastidious, and the severe inroads the buses have made on the passenger traffic of railroads.

Since the proposition of keeping cars in presentable condition is a duty of the car department, it behooves us, the carmen, to put forth every effort to attain this end most economically. Proper survey should be made of all points where passenger cars are cleaned, and the condition fully studied, in order to bring about the desired result.

It is possible that many of us have looked upon the cleaning of passenger cars as a necessary evil and have been prone to follow, in many cases, the lines of least resistance.

The first and foremost requirement in connection with the proper cleaning and caring for passenger equipment, is a properly organized group of well trained men, working as a unit, carefully supervised; because where human element is involved, in many undertakings, its efficiency will only be as great and enthusiastic as that of its leader. Consequently, great care should be taken in selecting a supervisor to handle men who are engaged in this sort of work.

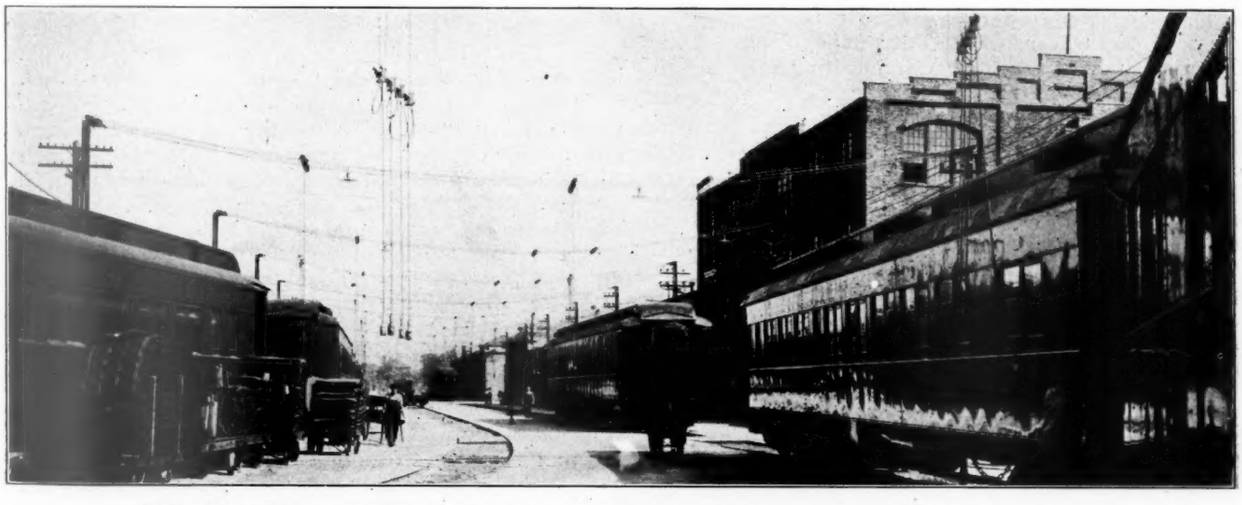
Two classes of passenger car cleaning

Passenger car cleaning on the whole can be easily divided into two general classes: first, terminal cleaning; second, heavy cleaning.

By terminal cleaning, I mean that cleaning which is given to every passenger car at the end of its trip. By heavy cleaning, I mean periodical scrubbing and renovating. These two classes of cleaning should be carried on as distinct and separate operations by groups of men working as separate units assigned to each.

The cost of cleaning will be governed a great deal, by the track layout available for such purposes. All coach cleaning tracks should be furnished with water, steam and compressed air, and should be well drained. In addition to the track layout and facilities, the men should be supplied with the proper tools to do this work, and all material should be placed in a convenient place centrally located to all tracks.

The first operation of terminal cleaning, or the cleaning that is given to every car at the end of its run, should be made by the man who is assigned to blow out cars, or use the vacuum. This man should first go through the car and raise all the windows, pick up all newspaper, fruit peeling, etc. He should start this cleaning on the vestibule of the car, being careful to clean around all of the vestibule trap doors, brake shaft and steam heat handles, as these places always catch more or less dirt, and if this is allowed to pile up, it will make an unsightly appearance. He should then go inside of the car, cleaning it for its full length, cleaning the seat cushions and backs, as well as the curtains, etc., as he goes along.



Pullman cleaning operations at Calumet yard, Chicago—Electric power and light drops shown

This man should be followed by the cuspidor cleaner. All of the cuspidors should be removed from the car and taken to a building assigned for that purpose, and thoroughly cleansed with hot water. A small amount of some standard disinfectant should then be put in them. After all other cleaning operations have

been performed the cuspidors should be returned to the car.

This latter man should be followed by the floor sweeper, whose duty it is to sweep the floor clean of all dust and dirt, using for this purpose a counter brush, so that he can get around all the seat castings, steam pipes and other fixtures that he could not ordinarily get around by using the regular floor broom. This man should also be equipped with a putty knife or scraper, so he can clean out all corners and around seat castings, and remove from the floor that pest of all car cleaners, chewing gum.

Working with the sweeper, there should be a man to clean out the toilet rooms and hoppers. This cleaning should be done with plenty of soap and water, to which has been added a little disinfectant.

This man should be followed by two men, one on each side of the car, whose duty it is to wipe down with rags, lightly saturated in renovating oil, the entire inside finish of the car, cleaning the windows on the inside at the same time closing them and adjusting the shades on an even line about 8 in. above the window sill.

The next man through the car, provided with a bucket of soap suds and a short broom, should scrub the floor, seat castings and steam pipes thoroughly, to be sure to get the dirt off the steam pipes, and steam pipe hoods. If there is any place in a passenger car where dirt will show up easily, it is on steam pipes and hoods, and during the winter time while steam is on in the cars, bad odors are very apt to arise.

The floor should then be mopped carefully by a man with a mop and a bucket of clear water, to which has been added a small per cent of disinfectant. No more than three or four square feet of floor space should be cleaned without rinsing the mop. A dirty mop will do more toward making an otherwise clean car have an unsightly appearance than anything I know of.

This should complete the interior cleaning of the car.

Outside cleaning

Working with the inside men, as listed above, should be four men on the outside, whose duty it is to wipe down the outside of the car, and clean all window glasses. These men should work from ladders built for that purpose, and during fair weather should be equipped with dry rags, some kind of good glass polish, a window stick and a putty knife which should be used in cleaning the corners of the window glass. I wish to add here that this is the most important part of cleaning the windows, for if allowed to go without scraping with a putty knife, or some other tool, the dirt will collect until the windows have a very unsightly appearance at the corners. For wiping the outside of the car, they should have dry waste lightly saturated with renovating oil, and tightly wrapped with string, in a flat shape; the renovating oil should be put on the waste and then beaten with a heavy piece of wood in order to distribute the oil evenly and prevent streaking the sides of the car.

Car cushions ready for initial blow-out with straight air before being thoroughly renovated in the Chicago shops of the C. & N. W.

During bad or rainy weather, the outside cleaning will, of course, have to be done by washing down the outside of cars with brushes and clear water.

This should conclude the work of terminal cleaning of passenger carrying cars.

The floors of all baggage cars and mail cars should be thoroughly cleaned and washed and properly aired. This work can be taken care of with regular assignment as listed above. For instance, the man who cleans out the toilet rooms and hoppers will not have enough to do to take up all his time, consequently he can be assigned to washing out all baggage cars. The man who blows out, or vacuum cleans passenger car interiors will have ample time to wash off all of the trucks and the floor sweeper should have sufficient time to sweep off all vestibule platforms.

Heavy cleaning every 60 days

You will notice I have specified a period of 60 days. The length of time between heavy cleanings will depend primarily upon the condition of the weather during that period. I feel that every coach and baggage car should be thoroughly scrubbed every 60 days, both inside and outside. The outside scrubbing may be done by using either soft soap, or by using a prepared solution of oxalic acid and common table syrup, mixed in water to 15 per cent volume. The outside work should be assigned to two men, working from trestles six feet high and twelve feet long made of light material so that they can be moved easily.

The scrubbing should be done with a short handle brush (old wash down brushes may be used for this purpose very economically). In scrubbing the exterior of the car a space of approximately six square feet should be scrubbed at a time, and then be washed off

with clear water, allowing none of the soap or the acid mixture to remain on the surface. After the entire exterior of the car has been scrubbed in this manner, it should then be rubbed down with waste saturated in renovating oil and followed by wiping down with dry waste, until the entire surface is dry.

The inside scrubbing or cleaning of the headlining, should be done by two men working from short trestles, using soft soap applied with regular painters' scrub brushes, and then washed off with a sponge. The headlining should then be wiped dry with either chamois skins or soft rags.

The car that receives heavy cleaning should also go through the interior terminal cleaning process as outlined above.

We must not overlook the trucks in our heavy cleaning. They should be washed off, cleaned with an acid mixture in order to remove all dust and grime, and after they have thoroughly dried, all exposed parts should be painted. It is also good practice, especially when the car is over-due for shops, to touch up the exposed portion of underframes with quick drying paint.

Much can be done toward improving the interior appearance of a passenger car by keeping the floors and seat castings, as well as steam pipes, painted.

I have made no mention of the cleaning of dining and business, or special cars, as this is a special work and it would make my paper too lengthy to properly describe a method that should be used in these cases.

The cleaning plan as outlined above, and the number of men given, is for a force capable of taking care of the cleaning of from 36 to 40 cars per day, which should be handled at a cost of approximately $1.40 per car, average for labor and material.

Discussion

W. Moore, (Frisco): There isn't anything we can do to our passenger equipment that will help the rail-

Cushions are handled with tractor and trailers at C. & N. W. shops—Note simple uncoupling arrangement

road any more than the cleanliness of passenger equipment.

One thing the author of the paper failed to mention is the beginning of the cleaning of passenger equipment and that is in the passenger shop. If all of you would check up, you would find that practically all passenger cars leave your shop in the same condition in which they came in, only the dirt has been covered up with a little paint. If you would clean those cars before you repair and paint them, and scrape the tobacco juice off the steam pipes, if you would look after your toilet bowls, your lavatories, your plumbing fixtures, and see that all the paint is taken off the inside of your toilets and give them a good treatment of paint, and see that your floors are thoroughly cleaned, if you would see that your windows are thoroughly cleaned, if you would see that all the old paint is taken off the roofs before painting them over, your passenger equipment would have a better appearance when it leaves the passenger shop and you would make it a great deal easier on the terminal points to keep those cars in good repair and keep them clean.

Cleanliness is something the traveling public is demanding today and you can first start toward the taking care of that equipment in your shops before the car leaves. When all of that is done you are going to have more satisfied passengers and more satisfied employees, and the cleaning of passenger equipment will be cut down to a minimum.

L. R. Bell, (I. G. N.): We have recently installed a schedule for car cleaning similar to the schedule used for light repair work on rip tracks, which we have found is proving very valuable.

Also, in connection with passenger car cleaning we go over all cars every six months, using a solution of oxalic acid, and then using a good renovater.

The cost of our cleaning has been reduced slightly by this scheduling of cleaning and we are getting very much better results. I think Mr. Stevens outlined a very good plan by which these cars should be cleaned. However, it could not be followed to the letter as outlined in Mr. Stevens' paper on account of the lack of conveniences we have. Most of this can be done, however, by the use of steam and air in cleaning the outside of our equipment.

We use air pressure with water in order to get force to knock off the dirt which has been collected and in some cases this dirt collection is caused by the use of oils on the trucks. We are not favorably impressed, however, with the oiling of trucks to a great extent as the collection of dirt prevents the absolute inspection of all parts of the truck. The dirt collects there too heavily to wash off.

In some instances where we find heavy oils have been applied, we use headlight oils sprayed on and let that dry and then wash it off with air pressure and with water.

The inside cleaning, I think, deserves as much attention as the outside cleaning.

J. R. Hayden, (M. K. T.): There are two general ways of cleaning the dust from the cushions, from the shades, and from the windows on the inside of the car. One is by the use of the straight air, and the other is by the use of the vacuum.

It is our practice to use straight air on all cars with the exception of dining cars and business cars. We are satisfied we can do this work considerably cheaper by the use of straight air. If there is any one in the room using the vacuum system of cleaning passenger cars, I would like to hear what success is being made and what the costs are.

Mr. Moore: In my mind and from our experience, vacuum cleaning of passenger equipment is the only system and the cost will not exceed 20 cents per car for air.

I don't believe you get any results from blowing out the car with air. The blowing out merely lightens up a little bit the duties of a cleaner, for the reason that instead of sweeping the floors, and dusting off the cushions of the seats and chairs, he merely takes the dirt up at the opposite end without sweeping, and the dirt and

the dust is merely being agitated and will eventually settle all over the entire car, particularly the upper and lower decks.

With this vacuum cleaner you can clean off the curtains, behind the curtains, and the upper and lower decks, and when your car leaves the terminal you have a good clean job and nothing is left inside of the car in the way of dirt. With the use of the broom or straight air, you may have the floor clean but the balance of the car has accumulated all that dirt.

Mr. Bell: I would like to ask the gentleman just what advantage he gets from the vacuum that he doesn't get from blowing the inside of the car. I would also like to ask if the vacuum cleaning doesn't cost a lot more than if the windows are raised and let the dirt blowout.

Mr. Moore: It is impossible after blowing the car and sweeping it with a broom to get the dirt out even if you leave the doors and windows open. The vacuum cleaner absorbs and retains in the sack all the dirt you get out of the car.

Mr. Hayden: I think the gentleman who presented the paper of the standard practices of cleaning passenger equipment has for some time been using both the syphon jet system of cleaning passenger cars and the straight air. I think it would be well to have him tell us which he prefers and what his experience has been with the use of both of them.

Mr. Stevens: We quite recently made a test both with blowing the cars with the straight air and also with the vacuum cleaner. In fact, the jet made by the Pullman Company is, by far, the best vacuum cleaner we have run across yet. With this jet we are able to pull 17 in. of vacuum and clean a car in 55 min. With the vacuum cleaner, the Eureka, it took us 1 hr. 40 min. to clean a car. With straight air we cleaned it in 28 min. and the car which was cleaned by straight air was by far the best job.

To make sure we started at one end of the car and blew it down all the way through. Then we went over the car with our inside men and got all the dirt off and we could find no dust inside the car whatever. In my estimation, the straight air in the cleaning of passenger equipment is the best method.

(A further extended discussion took place but no conclusions were reached. The discussion indicated that the vacuum is better for relatively light cleaning operations but for heavy cleaning, straight air will blow the dirt from behind radiator pipes, under seat springs and other places which the vacuum will not reach.—EDITOR.)

Spring bucker-up relieves fatigue

ONE of the hardest jobs in a car repair shop is bucking-up for the riveter. The constant vibration transmitted to the arms and shoulders through the ordinary type of bucking-up tool is fatiguing to the repair man. The bucker-up shown in the illustration was designed with the special purpose of taking up the vibration as much as possible. It consists essentially of a handle reclaimed from a worn out air-operated riveter, a round bar about 1½ in. in diameter and 12 in. long, a coil spring and the head.

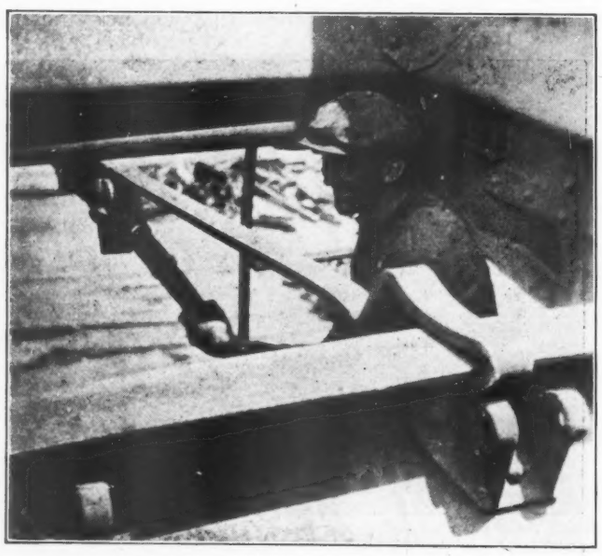
The bar is threaded at one end and screwed tightly into the handle. The coil spring is slipped over the bar so that one end rests against the tapped portion of the handle. The head is screwed into a sleeve which fits over the end of the bar and rests against the coil spring. Sufficient clearance is provided between the end of the bar and the base of the head to allow for compression of the spring. The head may be removed

Bucker-up designed to absorb the vibration set up by the riveting hammer

and sent to the smith shop for redressing and another one inserted whenever necessary.

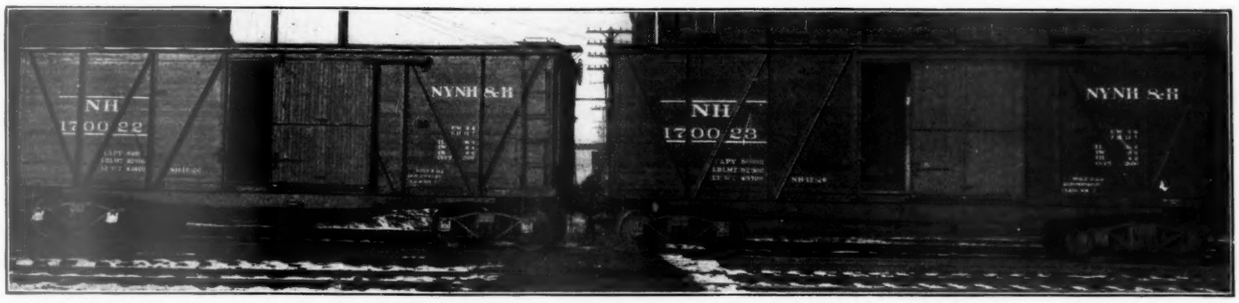
An anchor for a turnbuckle

THE carman in the photograph wears the smile that won't come off. He has just discovered a method of anchoring his turnbuckle safely to the center sill while drawing in a bulge in the side of a steel coal car, at the Denver shops of the Denver & Rio Grande Western. As the turnbuckle is too short to reach from the side of the car to the center sill, a 3½-ft. section of



A method of anchoring a turnbuckle safely to center sill

3-in. by ¾-in. steel was shaped to reach from the turnbuckle to the car center sill. A small broad hook the full width of the strap was shaped to fit over one end of the turnbuckle. The larger hook on the other end of the 3½-ft. section clasps the flange of the center sill, while an abrupt angle a few inches from the end of the hook serves to bring the anchor and turnbuckle in line. The width of the turnbuckle and anchor hooks keep the whole from turning while the buckle is being screwed up.



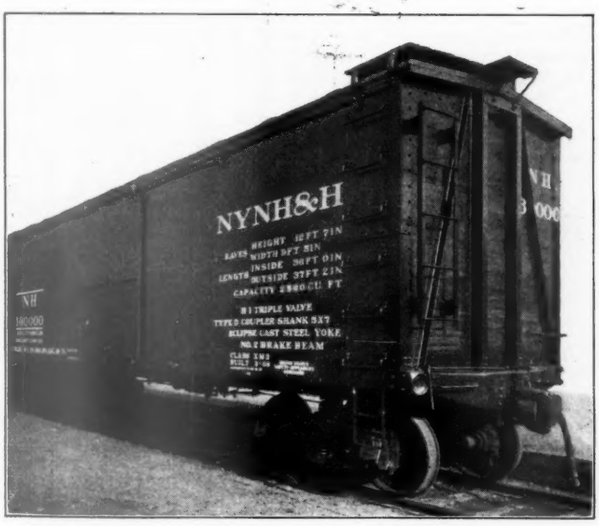
Forty-ton, single sheathed box cars rebuilt at New Haven

Rebuilding redesigned box cars on the New Haven

Old shop facilities with modern tools used to good advantage—Material distribution important

THE New York, New Haven & Hartford is now carrying out a program at New Haven, Conn., of rebuilding a series of 30-ton, double-sheathed and 40-ton single-sheathed, steel frame box cars. These cars, which have been in service for some years, have been completely redesigned for two purposes: first, to strengthen the cars, and, second, to reduce future maintenance expenses.

When the cars are taken into the shop, they are stripped of all wood structure. The underframe is straightened and a full bottom cover plate applied to the center sills to increase the strength. All of the original end sills are removed and new end sills ap-



One of the New Haven 30-ton box cars redesigned to increase its strength

plied, which increases the strength of the ends of the cars over the original design. The original light capacity draft gears, in a pocket not A. R. A.—standard are removed and replaced with modern friction type draft gears with cast steel yokes and Type D couplers. Integral rear draft lugs and bolster center fillers are applied as well as combined striking plates and front draft lugs making a standard pocket arrangement. All defective underframe details are either repaired or removed and replaced by new.

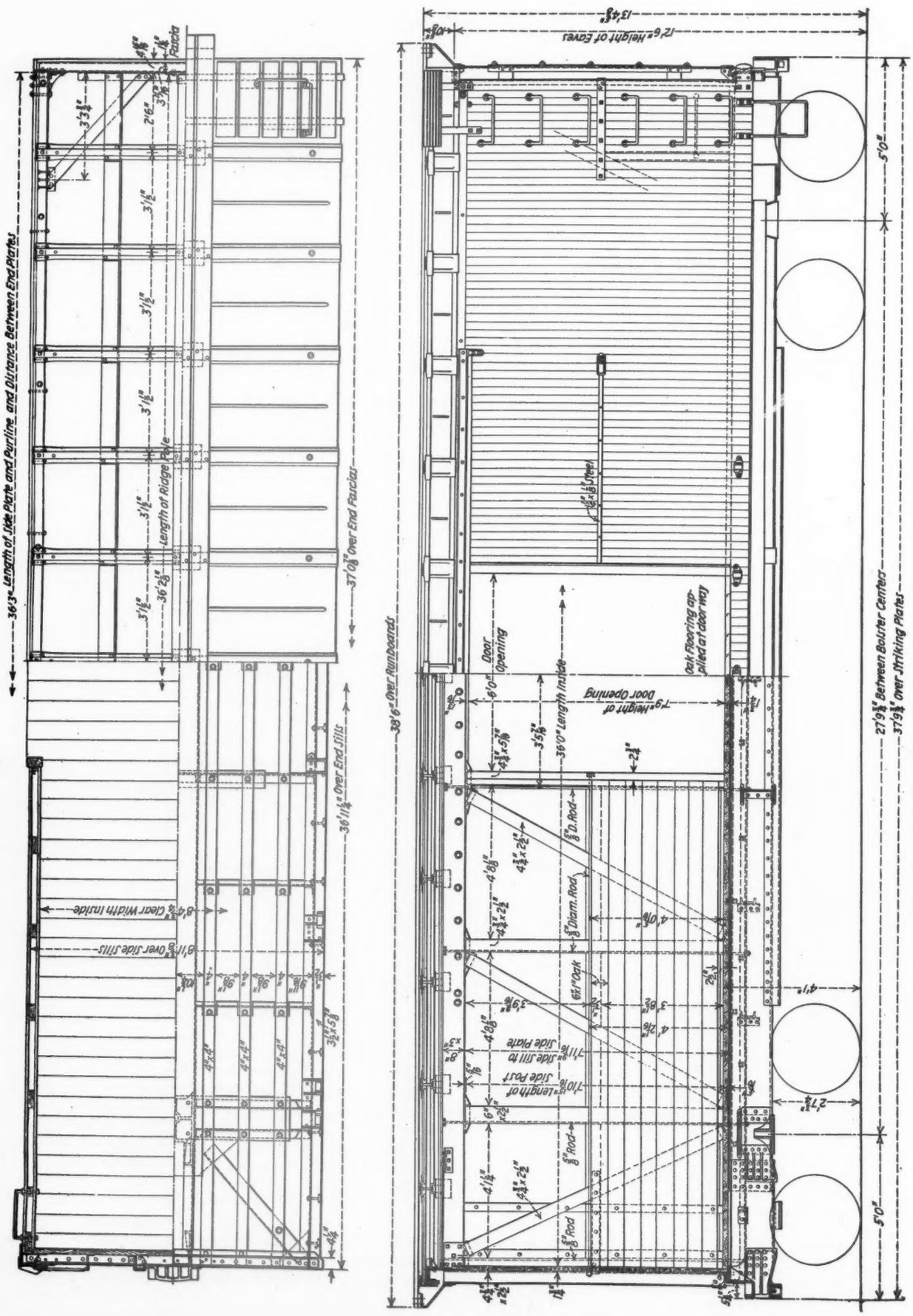
The trucks are thoroughly overhauled and new journal boxes, bearings, wheels, etc., are applied where necessary. Where the trucks are equipped with pressed steel bolsters, they are either reinforced or are scrapped and replaced with cast steel bolsters. The old design malleable column castings are replaced with heavier steel castings. The arch bars are reset where necessary and No. 2 brake beams applied.

The superstructure

The original superstructure of light framing is replaced by posts and braces that give approximately 25 per cent increase in strength. The framing consists of 6-in. by 2½-in. side posts at the bolsters with 4¾-in. by 2½-in. side posts at other locations and 4¾-in. by 2½-in. side braces. The small malleable iron post and brace pockets used in the original design have been replaced by pockets of heavier and larger design, which, in turn, are riveted directly to the steel side sills instead of resting on the wood side sills. The inside lining, which extends 4 ft. 5/16 in. above the floor, is made of 13/16-in. yellow pine with a 1-in. by 6-in. oak belt rail nailed to the girth. Standard size car sheathing is used. Particular attention has been given to making all of the joints thoroughly tight. Vertical tie rods ⅝-in. in diameter at each side post extend from the top of the side plate through the lower flange of the Z-section side sill. In addition, a ⅝-in. tie rod runs from each door post to the end of the car at a height of 4 ft. 5/16 in. above the floor. The oak flooring is nailed to 4-in. by 4-in. stringers, 9⅛ in. apart.

Reinforced ends

Steel reinforced ends using Z-bar end posts and angle diagonals, have been applied to a large number of the cars, other cars being equipped with all-steel ends. All of the cars are fitted with pressed steel end plates.



Elevation and plan of the New Haven redesigned 30-ton box car

The 6-ft. door opening is framed by 4¾-in. by 5-7/16-in. door posts. Metal-bound doors have been applied to some of the cars and all-steel doors to the others.

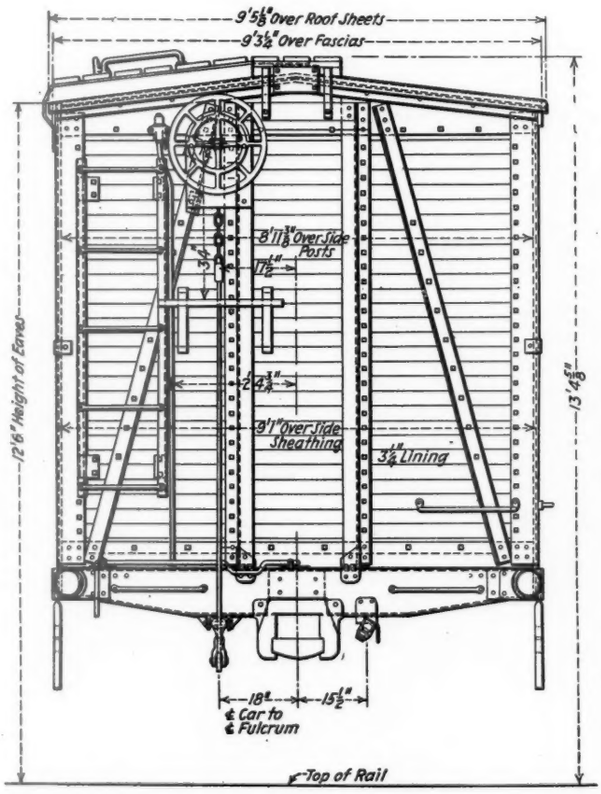
They are top hung, equipped with combination door stop locks and door closing and starting devices. Pressed steel carlines, 3 ft. 1½-in. between centers, support the outside metal roofs.

Principal dimensions of 30-ton cars

The inside length, width and height are 36 ft. 3 in., 8 ft. 4¾ in., and 8 ft. 5 9/16 in., respectively. The height from the rail to the running board is 13 ft. 4-⅝ in. The length over the striking plates is 37 ft. 9¾ in. and over the end sills 36 ft. 11¼ in. The width over the side sills is 8 ft. 11⅜ in. and over the eaves, 9 ft. 5⅛ in. The distance between the bolster centers is 27 ft. 9¾ in.

The shop facilities

When the New Haven decided to rebuild these cars, the question arose as to whether to build new shops or to modernize existing shop facilities to handle the work. It was decided that, rather than to invest in



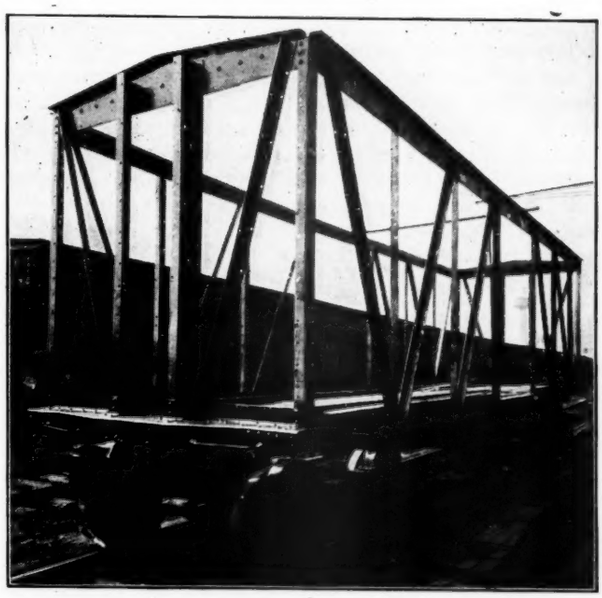
End view of the New Haven 30-ton box car

new shops to meet a temporary condition, it was advisable to make improvements to the shops at New Haven, Conn. Part of these shops were used for car repairs and the remainder was originally an engine terminal consisting of two enginehouses, one under cover containing 38 tracks, and the other a complete circle containing 40 tracks located outdoors. The outside repair tracks are served by a 75-ft. turntable and the repair tracks under cover are served by a 65-ft. turntable.

Some improvements were made to the old car shop buildings. Two of the shops adjoin each other. The roof of the shop in which the steel framing is fabricated for the 40-ton single sheathed box cars was raised 25 ft. in order to install a 10-ton Niles traveling crane. This shop, together with the adjoining shop, was lengthened 90 ft. The eight repair tracks in these two shops will hold from 35 to 40 cars. Located along the west side of the two main shops is a smaller shop in which are four repair tracks that will accommodate a total of 14 cars. No additions were made to this shop. In addition to these improvements, a new paint shop, 70 ft. wide and 300 ft. in length, was constructed of steel and glass. The three tracks in this shop will hold 24 cars.

New machine tools and shop equipment added

It was realized that in order to secure an adequate output the shops must be tooled properly. An adequate supply of oil furnaces, pneumatic hand tools and welding equipment was purchased. Oxygen, acetylene and air outlets are available at each radial repair track. Two new high capacity air compressors were installed in a new fireproof building. The enginehouse under cover in which all repairs are made to the steel underframes and trucks, was equipped several years ago with a punch and shear, a steam hammer, two oil furnaces, a hydraulic press, a large air clamp, an air operated bull-dozer for straightening parts, two drilling machines, one



Steel frame work of 40-ton box cars made from salvaged materials

double head bolt cutter and a floor grinder. Chain hoists have been installed where needed. Four electric trucks, one with a boom and one Fordson tractor, have been purchased for the distribution of material. A discarded maintenance of way track car powered by a Buda engine has been rebuilt to haul long timbers such as side sills, as shown in one of the illustrations. The maximum load consists of 24 side sills, 4 in. by 6 in. by 37 ft. A Plymouth gasoline dinky locomotive hauls the cars from shop to shop.

Passing the cars through the shop

The three tracks on which the superstructures are removed from the cars are located along the west side

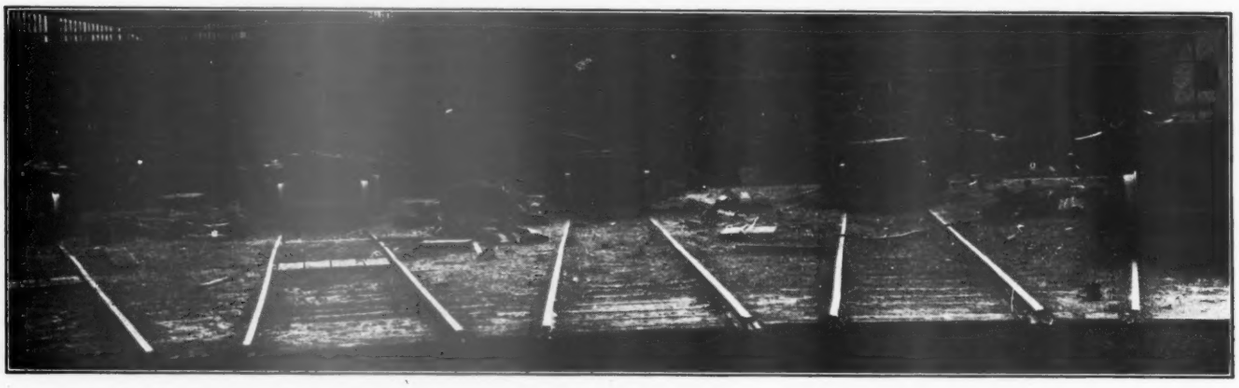
of the shops facing the waterfront. The 15-ton Browning locomotive crane operates on the track nearest the waterfront. The cars to be stripped are placed on the adjoining track. A third track is used for the storage of cars awaiting repairs. An average of 12 cars a day are stripped. As may be seen from one of the illustrations, the wooden superstructures are thrown on the river bank where they are burned. As will be explained later, the steel framework of the 40-ton cars is made from salvaged material. This material is salvaged at the stripping tracks. The stripping gang consists of 14 men which include the strippers, acetylene cutters and hoist operators.

The cars are now moved to the underframe stripping gang. This work is done on the outside repair tracks which were formerly used for engine repairs. At this point the underframes are scraped thoroughly and all defective parts removed and scrapped. The couplers and draft gears are removed and repaired. Inspection starts at this point. The column castings and bolsters are partly repaired at this point and the lye vats are located near these tracks. The vats are used principally for cleaning journal boxes and contained parts. The spring repair plant is located near the lye vats. The underframe stripping gang consists of 19 men.

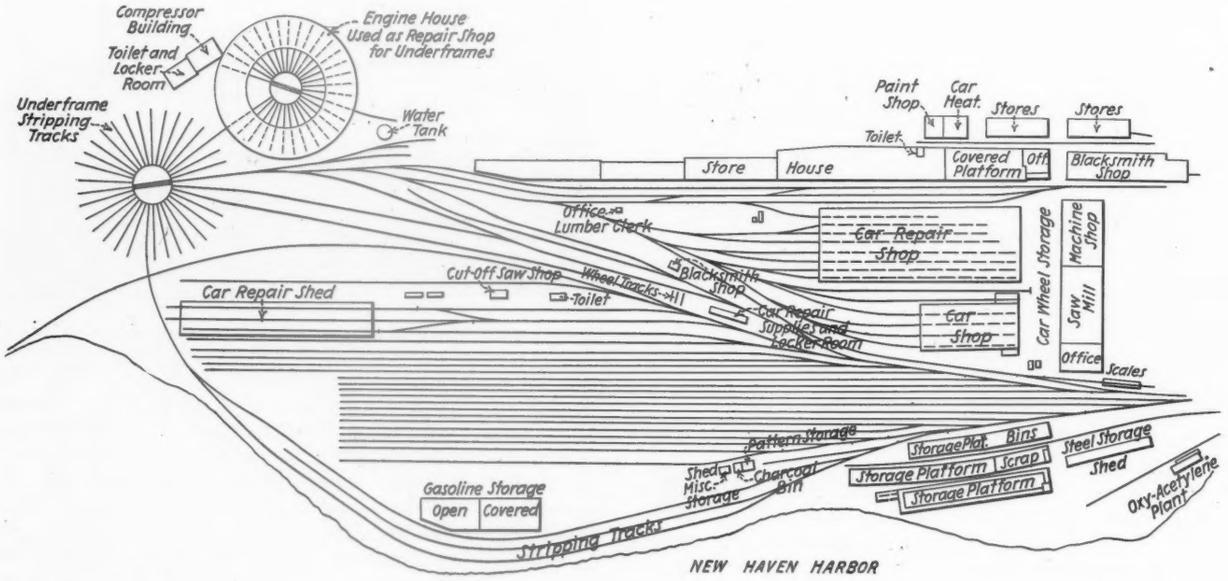
After the cars have been cleaned, they are moved into the old enginehouse under cover in which are 38 repair tracks, 24 of which are used for underframe repairs. The frames are raised by jacks and the trucks removed, after which the frames are lowered on horses. New end sills and bottom cover plates are applied. All bent parts are removed, straightened and reapplied.

The new draft gears and couplers are applied. Integral rear draft lugs and bolster center fillers and combined striking plates and front draft lugs are applied. All defective underframe details are either repaired or removed and replaced by new. All of this work is done by two gangs. The fitting-up gang consists of 41 men and the riveting gang consists of 34 men. The two gangs move from one track to another.

While the underframe repairs are being made, the trucks are receiving a complete overhauling on three tracks set aside for this work. These tracks are served by three one ton monorail chain hoists. The trucks are thoroughly overhauled and new journal boxes, bearings, wheels, etc., are applied where needed. Where the trucks are equipped with pressed steel bolsters, they are either reinforced or are scrapped and replaced with cast steel bolsters. The old design malleable column castings are replaced with properly de-



The underframes are thoroughly scraped and all scrap material removed on the outside radial tracks



A plan view of the shop buildings and track facilities of the freight car repair shop at New Haven, Conn.

signed steel castings. The arch bars are reset when necessary and No. 2 brake beams applied. The truck gang consists of 32 repairmen, including the blacksmiths. After the trucks are replaced under the frames, the side bearings are adjusted. The underframes are now removed to a track near the stripping tracks where they are sprayed with a coat of heavy black cement paint to prevent corrosion. The cars are now ready for the super-structure.

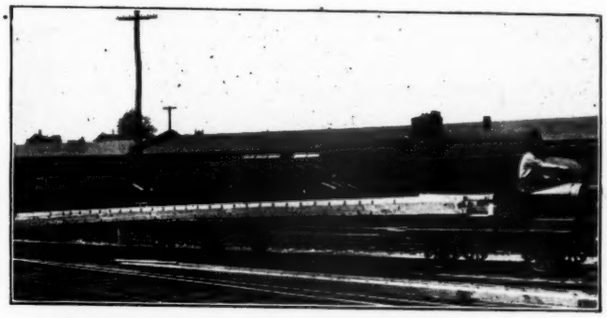
How the superstructure is applied

Up to this point the 30-ton and 40-ton box cars receive the same treatment. The steel framing of the 40-ton single-sheathed cars is made from material reclaimed from old cars. Referring to the illustration showing one of these cars with the steel framing completed ready for the sheathing, the two side plates are

The superstructure stripping tracks

made from reclaimed fish belly side sills. Three of the latter are cut up to secure two side plates. The end framing is made from reclaimed Z-bars and angles with end plates of new material. The side sills are made from scrap material, which is first straightened and the old holes filled up by the oxy-acetylene process, after which new holes are punched. The pieces are welded togther to obtain the required length. The end frames are fabricated on the jigs shown in one of the illustrations.

These various parts are cut from scrap material by an automatic gas cutting machine equipped with two cutting torches. The bed of the machine is 40 ft. in length. In addition to the parts listed above, the machine is used to cut from scrap material such parts as gusset plates, door posts, side sills and door guide brackets. One man



Utilizing a track motor car to haul heavy timbers

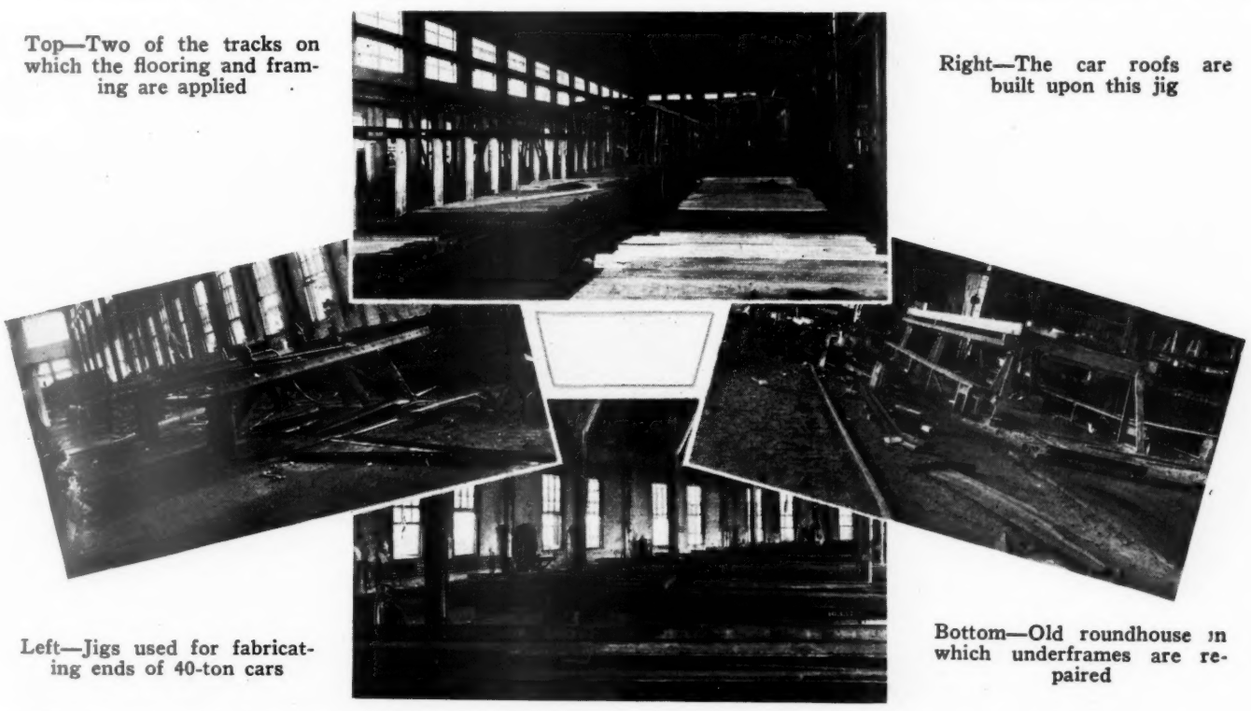
operates the machine. A gang of 58 men is required for fabricating and assembling the steel frame work for the 40-ton cars. The gang includes the crane operator, the floorman for the crane and the toolroom attendant. The output of these cars is two a day.

All of the cars are now ready to receive the floors, sheathing, roof, etc. This work is divided between two gangs. One gang consisting of 47 men applies the nailing sills, flooring and framing complete. The other gang of 62 men applies the sheathing, doors, roofing and safety appliances. At the same time the air brake gang consisting of 11 men is completing its work. The roofs are assembled complete in a jig on the floor and then lifted on the cars by the crane.

After all the wood work is completed, the cars are moved to the paint shop, where they receive two coats of paint and are stenciled. A gang of 11 men is assigned to this work. It requires three days to complete the painting of a car. The cars then receive final inspection after which they are weighed and released for service.

Top—Two of the tracks on which the flooring and framing are applied

Right—The car roofs are built upon this jig



Left—Jigs used for fabricating ends of 40-ton cars

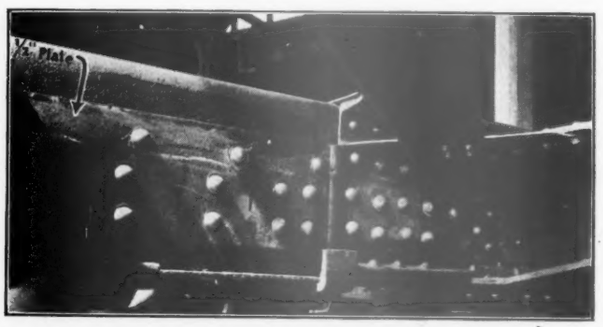
Bottom—Old roundhouse in which underframes are repaired

How production has been increased

When the shops were first put into operation it was realized that it would require skillful management to build up the output to 12 cars a day, which was reached during August, 1927. The chart showing the output by months for a period of one year beginning with August, 1926, tells its own story. During August, 1926, 71 cars were completed which required 4.9 men per car. The number of men required per car has been steadily reduced. The low point was reached during April, 1927, when 2.3 men were required to produce each of the 241 cars completed. From August, 1926, to April, 1927, the car output increased 186 per cent while the man load increased only 35 per cent. From December, 1926, to April, 1927, the man load has remained practically constant yet car production since December has increased about 100 per cent in terms of the August, 1926, production. In the same period, the labor cost per car has been reduced 46 per cent.

Personnel of the shop forces located at the Lamberton street freight car repair shops of the New Haven

No. of men	Employed as
1	Superintendent of shops
1	General foreman
14	Superstructure stripping gang
19	Underframe stripping gang
32	Truck gang
41	Underframe fitting up gang
34	Underframe riveting gang
47	Nailing sills, flooring and framing gang
62	Sheathing, doors, roofing and safety appliance gang
58	Fabricating steel work for 40-ton cars
36	Mill shop
11	Air brake gang
11	Painters
5	Truck operators
67	Labor gang



The draft sill is reinforced by a ½-in. plate which is extended around on the bolster to engage three additional rivets

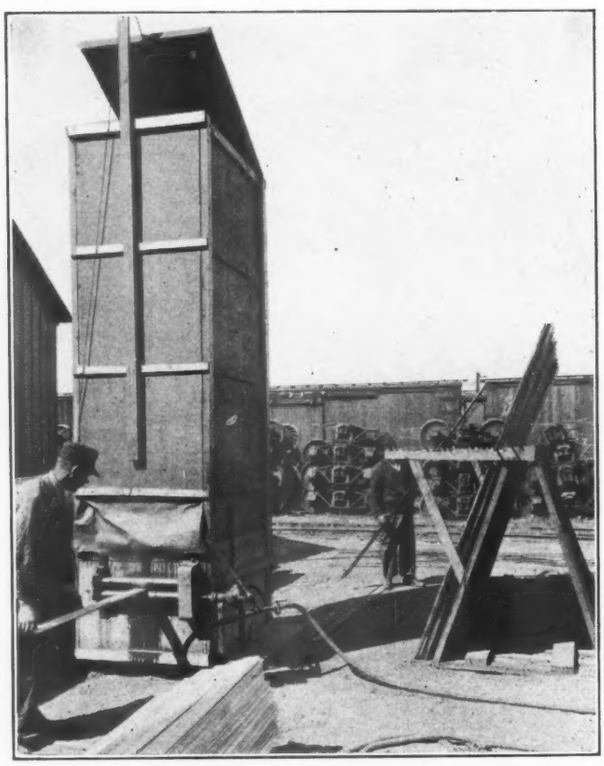
Several factors are responsible for this splendid performance. Much thought has been given to maintaining an adequate supply of repair parts. Charts in blueprint form have been prepared which show at the beginning of each week, the number of parts required for each operation for each week. For example, the chart showing the castings required for the underframe and truck shops indicates in the first column the kind of material, whether malleable iron or cast iron; the second column a description of the parts such as angle cock brackets; the third column the pattern number, the fourth column the number on hand at the beginning of each week. The charts are marked with red, orange or yellow crayon. The red indicates the number of pieces on hand, the orange the number of pieces ordered and enroute and the yellow the number of pieces ordered but not shipped. These charts give a clear picture of the material situation and reduce to a minimum, work being held up waiting repair parts.

Other factors that have helped increase production are the splendidly worked out material delivery system, the bonus system, system of inspection and the fine spirit of cooperation. Many yards of concrete runways have been laid to facilitate the delivery of material.

The cars are not only being rebuilt at a minimum of expense, but by reason of the character of the repairs, they are expected to play a decided part in materially reducing future maintenance expense.

Spray painting box car siding

SHOWN in the illustration is an experimental installation built for the purpose of putting the first coat of paint on car siding as it is delivered to the car repair shop. It consists of a ventilator shaft, two rollers, operated by an air motor, and a spray painting device which is placed inside the ventilator shaft. As each length of siding is unloaded from the car, it is passed between the rollers into the ventilator shaft, where it is painted, and carried on out the opposite side. The spray nozzle is located immediately beyond the rollers. The siding is piled in the rack as fast as it is received from the painting device.



Experimental installation which has expedited the work of painting box car siding

It is planned to locate this equipment inside the lumber storage shed so that the siding can be passed into the shed and through the spray painting device as it is unloaded from the car. The rollers will be placed in the wall of the shed and the ventilator shaft built up through the roof. The siding will be piled on racks, similar to that shown in the illustration, until the paint has dried, after which it will be stored until ready for use.

Resumé brings Arbitration Decisions up to date

A total of 33 decisions involving cases from No. 1499 to No. 1532, inclusive, briefly summarized

IN order to publish in the March issue abstracts of decisions printed in the current circular of decisions of the Arbitration Committee, and to keep future decisions noted in these columns approximately up to date, the thirty-three decisions that precede this circular, and which have not already been abstracted in these columns, will be briefly reviewed in the following paragraphs. Of the 33 decisions rendered in cases from Nos. 1499 to 1532, inclusive, 12 (Cases Nos. 1501, 3, 5, 6, 12, 13, 15, 19, 24, 29, 31 and 32) involve Rule 32. The decisions were equally divided against the owners and the handling lines. Case No. 1499, involving Rule 12, referred to the cleaning of air brakes on six cars for which the owner refused to pay the charges, claiming that the brakes were not cleaned as stenciled and charged for. The decision was rendered against the owner. Decision No. 1379, which was published on page 619 in the October, 1926, issue of the magazine, applies to this case. Case No. 1500, involving Item 157, Rule 101, refers to an incident where an overcharge was made for repairing automobile doors of the double reinforced type. The decision stated that the charge should not exceed the price for a door as referred to in the rule.

Cases Nos. 1502 and 1507 hinge on the interpretation of Rule 60. The responsibility for the second cleaning of air brakes within six months on account of illegible stencil marks, is the point upon which the disputing railroads could not agree. The decisions in both cases refer back to the decision rendered in case No. 1490 which was published on page 19, in the January, 1928, issue of the *Railway Mechanical Engineer*.

Cases Nos. 1504 and 1523, involving Rule 91, refer to the adjustment of undercharges found when a recheck was made of the original records. The decision rendered for Case No .1504, which is interesting, reads as follows: "Rule 91, Section (e), requires adjustment of undercharges found on checking bills payable by the company against which the bill is rendered. It is inadvisable, however, to require an adjustment of such undercharges as may be found on rechecking original records by the company rendering the bill. The Supplementary Regulations require adjustment of overcharges which may be developed by a recheck of the records of the repairing line, there being no such requirement in the case of undercharges. Therefore, the contention of the repairing road is not sustained."

In rendering its opinion on Case No. 1523, the Committee stated that the decision for Case No. 1504 applied.

Case No. 1508, involving Rule 2, was unusual in that only one road would agree to submit the case to the Committee for a decision. The repairing line rendered bills against the originating line for adjustment of lading and application of proper doorway on seven cars received from a delivery line, in accordance with the provisions of A. R. A car service Rule 14. The originating line did not dispute the fact that the work was performed, but declined to accept the bills and make a settlement based on a circular issued to the effect that after a certain date it would not render or pay bills based on Rule 14. The contention of the repairing line was sustained in view of Rule 130, as well as Section (h) of Rule 2, in connection with Section (e) of Car Service Rule 14, in effect during the period in question.

The question of the responsibility for wrong repairs as set forth in Rule 88, Interpretation No. 2, was involved in Case No. 1509. The repairing line was held responsible for the material as well as the labor involved in standardizing wrong repairs.

The facts set forth in cases Nos. 1510 and 1530, involving Rule 43, were that the handling line notified the owner that one of its tank cars was found leaking and damaged, which was owner's responsibility, and requested disposition of the car. The owner refused to pay the bill, contending that the handling line failed to establish a claim of owner's responsibility. The owner's contention was, in both cases, sustained by the Committee.

Case No. 1511, involving Rule 122, Interpretation No. 3, refers to a basis for computing the depreciation of a destroyed car. The owner claimed that the car had been rebuilt new in 1922, using some material salvaged from cars built in 1907. The handling line contended that the depreciation should have been computed from 1907. The Committee sustained the contentions of the handling line.

In Case No. 1514, 5-in. by 7-in. Type D couplers were used to replace on two cars 5-in. by 5-in. couplers standard to the cars. The owner contended that the charge should not exceed that for the 5-in. by 5-in. common couplers applied because the substitution of 5-in. by 7-in. for 5-in. by 5-in. couplers is prohibited in Rule 17 (c), last paragraph. The repairing line maintained that the charges were correct and supported by Rule 17. The decision was to the effect that "both parties agreed that the substitution of the 5-in. by 7-in. couplers was improper. Under these conditions, the charge for the new couplers should not exceed the value of new 5-in. by 5-in. couplers standard to the car."

Cases Nos. 1516 and 1517, involving the second paragraph of Rule 4, refer to emptying and reloading a car against which a defect card had been issued for slight damages. The road issuing the defect card contended that the owner should have immediately sent the car to the shop for repairs and not have continued it in service. The owner contended that Rule 4 did not cover such cases. The following decision, which is of interest, was rendered: "Rule 4 is intended to prohibit the issuance of defect cards for slight damage existing on cars in interchange. Therefore, the wording 'That of itself does not require repairs before reloading of

car,' as expressed in the rule, is a measure for the guidance of inspectors in the determination of the responsibility for damage. It should not be used for the purpose of invalidating a defect card issued in good faith and under the provisions of the rules.

"The circumstances in this case are not such as would invalidate the defect card. The bill of the owner is sustained."

The decision rendered for Case No. 1517 was identical to the above quoted decision.

Case No. 1518, involving Rule 86, refers to the responsibility for recording correct axle dimensions. The Committee pointed out that decision No. 1478 (published on page 736, in the November, 1927, issue) was similar in principle.

Case No. 1520 was unusual in that the handling line rendered a bill against the owner for the replacement in mail and baggage cars of brooms, feather dusters, stools and water pails for which it added labor charges varying from .3 to .5 hours per article. The owner to pay for labor charges, as such a charge was not stipulated in passenger interchange Rule 21. The owner's contention was sustained by the Committee.

In Case No. 1521, involving Rule 30, one road reweighed a car and failed to obliterate the old stenciling marks with the result that the second road reweighed the car but obliterated the old stenciling. Both roads billed the owner for reweighing the car. The owner requested the first road to cancel its charge which it refused to do. The Committee sustained the owner's request.

In Case No. 1522, the repairing line ordered material from the owner who, not having it on hand, ordered it from the manufacturer, directing that the material be sent collect direct to the repairing line. The owner rendered a bill for material plus 15 per cent for freight charges and stores expense, which the repairing line refused to pay. The contention of the repairing line was sustained. Decision No. 1489, (published on page 788, in the December issue) applies.

In Case No. 1526, the repairing line requested the owner to furnish one metal end sheet for B end, left side of coupler, on account of handling line responsibility. The owner declined to ship the material, claiming that according to Rule 122, the repairing line should furnish repair parts. The contention of the owner was sustained by the Committee.

According to the facts set forth in Case No. 1527, a tank car company made repairs to 18 of its cars on authority of defect card issued by the handling line, which objected to some of the charges, claiming they were excessive. The owner claimed that because it purchased the parts for its cars from a manufacturer it was justified in charging their invoice cost, plus 15 per cent for the various parts in question, applied to its cars on authority of defect cards per Rule 105. The line issuing the defect cards contended that the owner should furnish the weights of the bolsters removed and applied and reduce the charge to conform with Items 188-A, Rule 101. The contentions of the line issuing the defect cards were sustained.

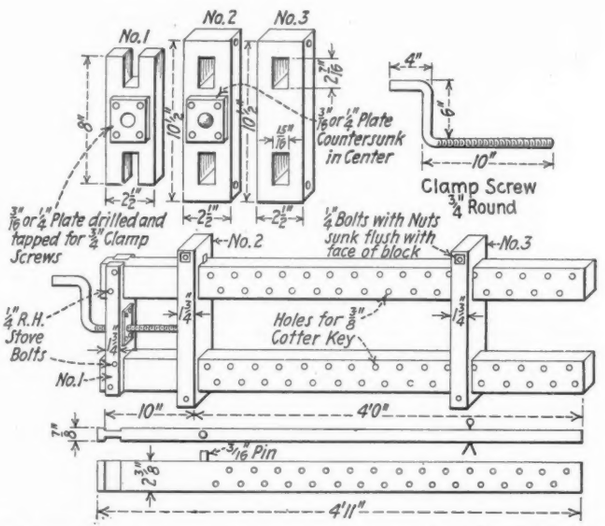
As stated in Case No. 1528, the repairing line changed a pair of wheels on account of one wheel having a worn flange. The axle removed had a 4 7/16-in. by 8 3/16-in. journal, a 5¾-in. wheel seat and a 5¼-in. center. The repairing line allowed only scrap credit for the axle removed on account of having an oversized journal and center. The owner contended that second-hand credit should have been allowed, according to Rule 98, section (c), last paragraph. The contentions of the owner were sustained.

A handy clamp for the woodworker

By Richard Stringle

Assistant general car foreman, C. & E. I., Danville, Ill.

ON page 152 in the March, 1927, issue of the *Railway Mechanical Engineer* appeared a description of a shop-made woodworker's clamp. The accompanying illustration shows a clamp which the writer considers a superior clamp for this class of work. The reason for preferring this design over the one shown in the March issue is that when the pressure is applied with the screws of that clamp, the tendency is for the boards being clamped to buckle. This cannot happen with the clamp illustrated because, by placing the clamp at an angle, pressure is applied to both the front and back of the board being glued.



This clamp applies pressure to both sides of the board being glued, thus preventing buckling

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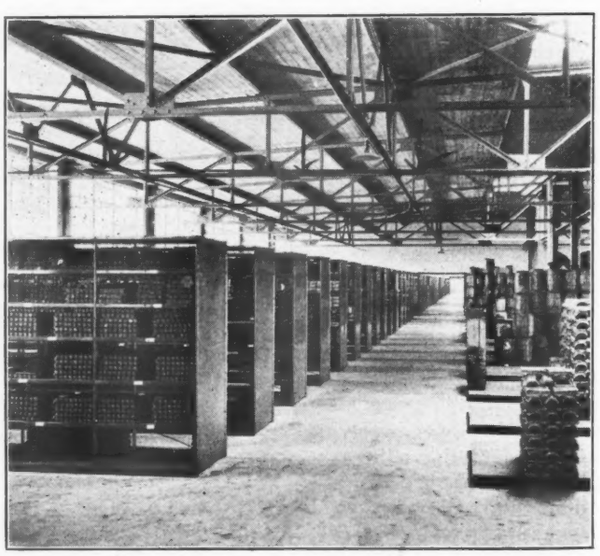


The Wabash at Decatur, Ill., has used metal shelfing to carry out the system of unit piling of car material

Method of locating eccentric crank arms

By P. J. Connors

Erecting shop foreman, Bessemer & Lake Erie, Greenville, Pa.

ONE of the difficult problems with which our shop has had to contend has been the locating of eccentric cranks and cutting keyways in the main crank pins. This work has often necessitated the holding up of locomotives in the shop, because the work could not be completed until the wheels were under the engine and the valves set. Formerly the procedure was to slot the keyway in the crank, apply the crank and adjust it on the crank pin, then lay off the keyway on the crank pin, remove the crank and drill the keyboard. This process was not only slow but the crank was often injured by the sledging necessary to remove it. In an effort to reduce the time required to do this work, we conducted some experiments and have finally perfected a method with which a considerable saving is being effected. The new method of locating cranks and cutting keyways in the main crank pins is shown in the illustration.

In Fig. 1, *A* is the crank arm, the pin end of which is bored out to a diameter which will accomodate all classes of main pins. It is provided with four movable blocks which serve as a chuck. The different sizes of pins are scribed on the blocks *B* and on the outer side of the arm. This makes it very easy to set true by moving the set screws back of these blocks the same as in a lathe chuck. The outer end of this arm is provided with a point, *C* which moves in the slot and may be lined for the different lengths of crank arms. These lengths are stamped at D and F with a center line *E* for locating the center of the keyway. This is used for all Baker, Walschaert and Southern valve gears.

To operate the device, it is placed on the crank pin and the chuck jaws are set down on the pin until it is just tight enough to be rotated easily by hand. The machinist then takes the centering gage *G*, which is provided with a removable center. This center fits into the center in the main axle and the base which is held up against the end surface of the axle. The centering gage is also provided with a movable outer cross bar *H*, which is graduated from the center of the gage *G* to the outer point *I* for different eccentric throws. These dimensions are stamped on the base of the gage *G* and on the cross bar *H* which eliminates the need of a blue print. Set the cross bar *H* at the required dimension on the print for the desired eccentric throw and the movable point *C* on the eccentric arm *A*. The dimensions stamped on the arm at *D* and *F* for crank arm lengths, correspond to those shown on the blue print. Then rotate

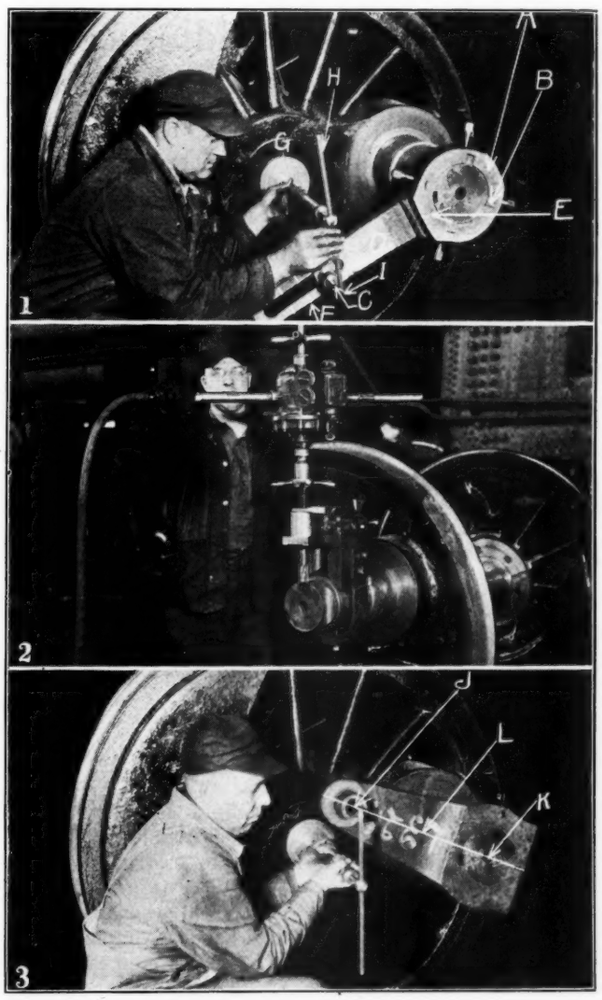


Fig 1.—Locating the eccentric crank; Fig. 2—Milling the Keyway; Fig. 3—Checking the crank arm after it has been applied

the crank arm *A* until the point *C* meets the point *I* on the cross bar *H* and then scribe the center line *E* on the

main pin for the center of the keyway. The keyway is then laid out and milled as shown in Fig. 2.

The regular crank arm shown in Fig. 3, which has been laid out as shown at *J*, *K* and *L*, and the keyway cut, is then applied to the pin and the key is driven part way in. It is then checked with the centering gage *G* and if found correct, the bolt hole is drilled, reamed and the bolt is fitted. After the bolt is fitted, it is again checked with the centering gage *G* as shown in Fig. 3. All this work is done before the wheels are placed under the locomotive.

The greatest difficulty we had with most devices for laying out crank pin keyways was that there was no way to check them after the crank was applied. If the crank changed during the operation of fitting the key and bolt, there was no way of detecting it. But by using the centering gage *G*, the crank arm can be checked at all times, with the rods on as well as with the rods off.

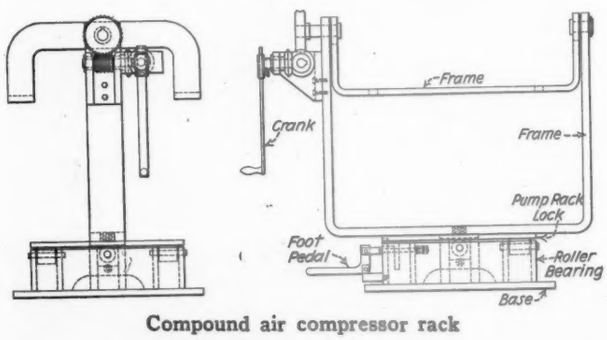
The method described not only saves time and labor in the application of eccentric cranks to crank pins, but also has been found to be accurate. It is used regularly and has proved to be satisfactory.

Repair rack for holding compound air compressors

By H. H. Henson
Machine shop foreman, Southern, Chattanooga, Tenn.

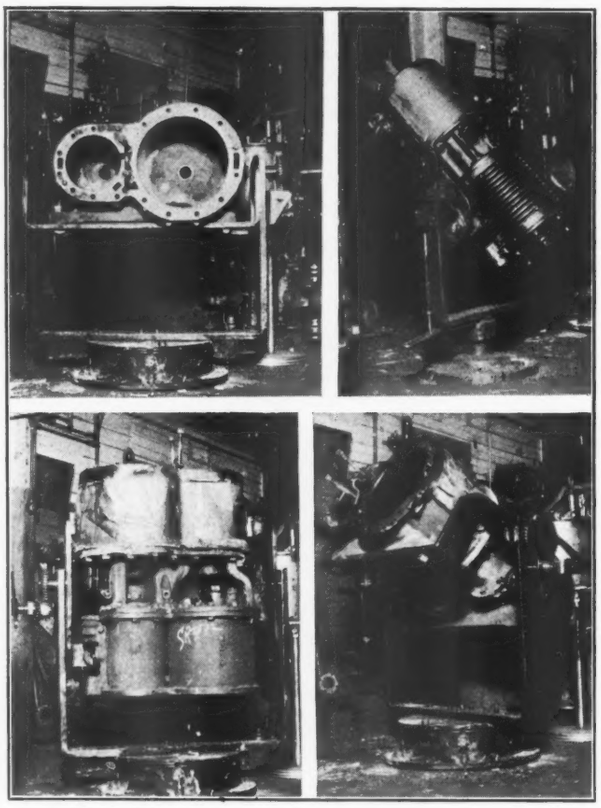
IT is a cumbersome job to handle a compound air compressor when receiving general repairs. It requires the services of a crane and two or more men in order to place the compressor in the different working positions. The illustrations show a rack for holding large compressors so that by turning a crank the unit can be placed in any working position.

There are no complicated parts involved in the construction of the device. A base plate 27½ in. in diameter and containing eight 1-in. holes is bolted to the floor. On top of the base sits a circular frame 22 in. in diameter which contains four rollers equally spaced. The pump rack lock, in the circumference of which are cut eight slots, equally spaced, rests on the four rollers. The main U-frame which measures 38⅝ in. inside of the vertical arms, is made of flat iron 5 in. wide by 1¼ in. thick. A 2-in. threaded hole is cut in the center of the bottom member of the frame. A swivel pin which is screwed into this hole fits in the center of the rack lock plate. The sub-frame or cradle which supports the compressor, revolves inside of the main frame on two trunnions. The compressor in the cradle is revolved to any position by a worm and gear operated by a crank. The device is locked in position by a foot pedal which permits a latch to drop into any of the eight latch slots in the rack lock plate.



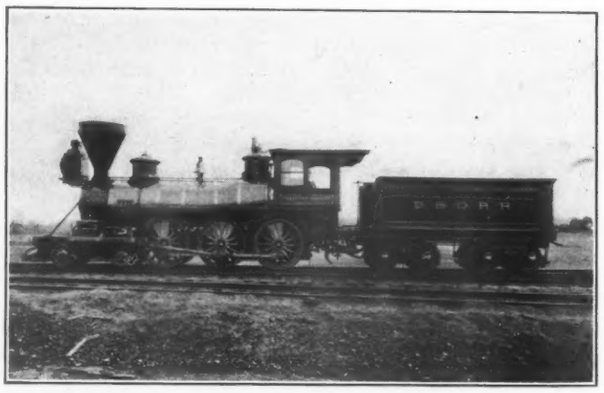
Compound air compressor rack

One of the illustrations shows a compressor held in the rack in various positions. In the horizontal position the workman can remove any of the accessible parts. In the angular position, the cylinder packing rings can be properly fitted to the cylinder bores. In the horizontal position, the boring bar can be assembled for reboring the cylinders without dismantling the cylinders to have them bored in the machine shop, thus saving considerable time and labor.



Upper left—In this position, the boring bar is assembled in the compressor; Upper right—A similar rack for a 9½-in. air compressor; Lower left—The rack in a vertical position where accessible parts can be easily removed; Lower right—The proper position for fitting cylinder packing

* * *



The "Thatcher Perkins"—1863—One of the locomotives exhibited during the Fair of the Iron Horse, held at Halethorpe, Md., September 24 to October 12, 1927

Quenching—A practical study of rapid cooling*

Discussion of the methods of quenching, speed plunging and the effect produced on various shapes

By Percy J. Haler
Principal, Leyton Technical College, Leyton, England

There are many factors which influence the rate of cooling, and the following are of great importance, namely, the mass and shape of the object cooled, the composition and temperature of the quenching medium, the velocity at which the object travels, and the direction in which the quenched object is plunged. It is still a debatable point as to which liquid gives the most rapid quench and Table I shows very divergent views, largely owing to the methods of quenching.

Table I—Relative values of quenching mediums

Speed in seconds	Quenching medium	Order of merit	Quenching medium
1.5	Mercury	1	Water spray
2.0	Water-pressure spray	2	Water at 20 deg. cent.
2.2	Rain water	3	Salt water
2.5	Hard, brine, and sea water	4	10 per cent sulphuric acid
3.0	Kerosene	5	Water at 50 deg. cent.
3.2	Light mineral oil	6	Mercury
3.5	Fresh fish oil	7	Linseed oil
3.6	Lard and old used fish oil	8	Water at 100 deg. cent.
3.9	Boiled linseed oil	9	Lead
3.9	Raw linseed oil	10	.....
(From Steel Thermal Treatment, by Urquhart.)		(Le Chatelier's experiments as plotted in Brearley's Heat Treatment of Tool Steel.)	

It will be noticed that Le Chatelier places water spray first and mercury sixth on the list, but these results were obtained in two different ways.

Urquhart carried out practical tests on 0.9 per cent carbon steels ½ in. by ¼ in. in section, heated to 778 deg. C. over a length of 2 in. and then plunged into the quenching medium. In this case the rate of cooling at about 720 deg. C. was measured. Le Chatelier heated small cylinders of steel into which a thermocouple was placed and then observed the relative time required to cool from 700 to 100 deg. C.

Benedicks conducted similar experiments where the specimen was carried in a circular arc through the water. According to him, the cooling property of a liquid is chiefly dependent on a high latent heat, the specific heat, conductivity and viscosity being of secondary importance. But these views are hardly in accordance with those of practical workmen and were not obtained by taking into account the usual rate of motion of the quenched object.

Common methods of quenching

Among the more common methods of quenching the following can be considered:

Hand quenching, where the object is held by the workman, usually by tongs, and is plunged into water with as great a velocity as possible.

Gravity quenching, where the object is released just as it meets the surface of the water and falls to the bottom of the tank.

Dump quenching, where the objects are released in a mass from the furnace and travel haphazardly through the quenching medium.

Spray quenching, in which specially designed hardening machines, work with water under a minimum pressure of 40 to 50 lb. and a maximum temperature of 15 deg. C.

There are also a number of other methods, but a great deal of hardened work is quenched by one of the first three mentioned.

Speed of plunging

It is difficult to get any reliable information as to the speed with which the object travels through the water, and experimenters do not refer to this.

In hand quenching there is a vigorous lunge, the speed toward the end of the stroke being limited by the tendency of the muscles to contract. If the tank is deep the movement is continued by bending the back, and at the end the upward stroke commences. The average velocity varies with the individual, but the highest obtained is 6 ft. per sec., for 20 in.; other results show 5 ft., 3.96 ft., and 3.58 ft. per sec. and retardation is very

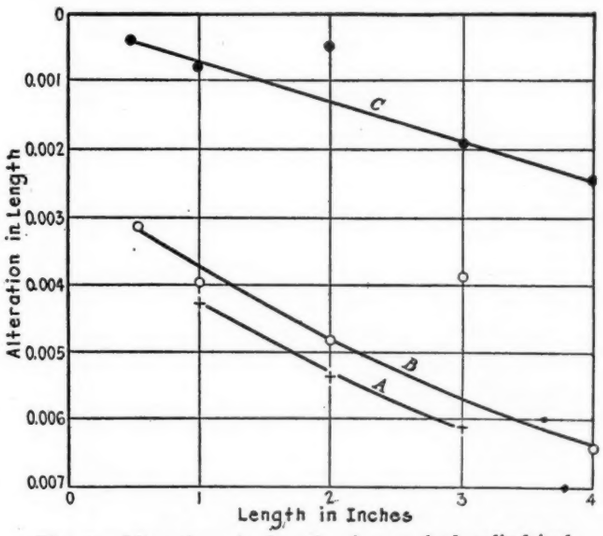


Fig. 1—Alterations in length of quenched cylindrical specimens

marked with certain individuals. Six feet per second gives a drastic quench.

In gravity quenching the object is released from the tongs just over the surface of the water, enters with no initial velocity, and at the end of about 2 ft. will have a velocity under 3 ft. per sec.

In the first case there is retardation of the specimen, and in the gravity quench, acceleration.

Dump quenching is the most barbarous method of all, and is one that few up-to-date firms would care to adopt. No two pieces are cooled at the same rate, and pieces still

* Abstract of a paper prepared for the American Society of Mechanical Engineers.

uncooled will lie at the bottom of the tank, affecting each other in an indeterminate way and tending to make up-to-date equipment useless. The workman allows the material to fall through the water by gravity with some initial velocity, generally in the wrong direction.

It will thus be seen that practically all experiments and most hardening operations are carried out with velocity

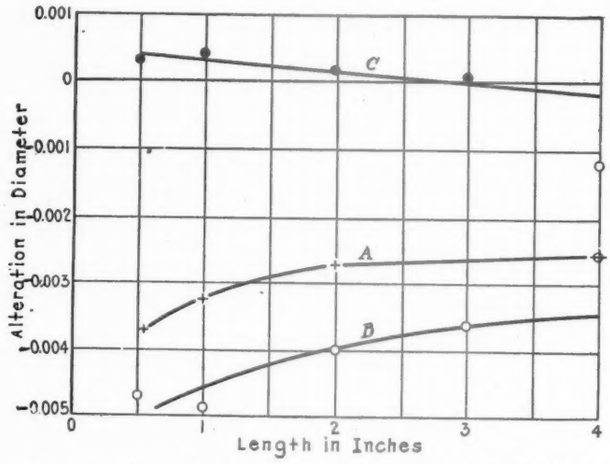


Fig. 2—Alterations in diameter of quenched cylindrical specimens

of entry into the quenching medium varying from a maximum of 6 ft. per sec. to 0 ft. per sec. and that consequently there is room for research. It has been pointed out in previous discussions of this subject that the distortion bears some definite relation to the quenching temperature consequent upon the actual shock, and it appears that in many cases the actual conditions of quenching are not so carefully studied as the actual condition of releasing an article to be quenched.

Usually the quenching tank is not deep enough and in hand, gravity, and dump quenching the work at a high temperature is left lying on the bottom or on a wire shelf to cool under the worst conditions.

Reference might be made to one or two recent attempts to regulate the velocity of quenching apart from spray quenching.

In a French rolling mill rail steel of 0.5 per cent carbon content is manufactured by passing the rail directly from the rolling mill at the finishing temperature to a trough of hot water, of sufficient length. It passes through the trough at such a speed as will secure quenching at the proper rate through the critical temperature, then passing to the cooling tanks in the ordinary way.

The heat treatment in the S.A.E. specifications for carbon steel when used for gears of heavy section is as follows: Normalize at 1,650 to 1,750 deg. F., carburize at 1,650 to 1,700 deg. F., cool in box, reheat to 1,600 to 1,650 deg. F., quench in water at 110 deg. F., reheat to 1,400 to 1,450 deg. F., quench in water at 110 deg. F., and draw at 250 to 500 deg. F.

It is probable that the quenching proviso of such a specification for heat treatment will ultimately be altered to read: "Quench in water at 110 deg. F. at a velocity of x ft. per sec."

Influence of direction of plunging on distortion produced

In studying Lineham's paper dealing with the hardening of screw gages with the least distortion in pitch, the author was struck with the variable results obtained. Furthermore, he had also learned from practical experience that it was possible to get widely different results under apparently the same conditions. After repeated failure it was found that the quenching bath was responsible for these variations, and the following tests are selected to illustrate the influence of the direction of plunging on the distortion produced.

A number of specimens were cut from the same mild-steel bar, were turned and ground to 0.9 in. outside diameter, drilled through the center and the hole reamed to ⅜ in. The pieces were of varying length and received the same heat treatment, being carburized at 850 deg. C. for three hours in eternite, allowed to cool, and then heated to 750 deg. C. The quenching velocity was approximately 6 ft. per sec.

Figs. 1, 2, 3, and 4 show the alterations in length diameter, volume, and density. Curves *A* in each case record results obtained when the specimens were plunged horizontally. Curves *B* are for specimens plunged horizontally and swished vigorously, while curves *C* are taken from vertical plunging.

In studying these results and the original data the following facts emerge: In vertical plunging the entry end is always found to have become larger than the

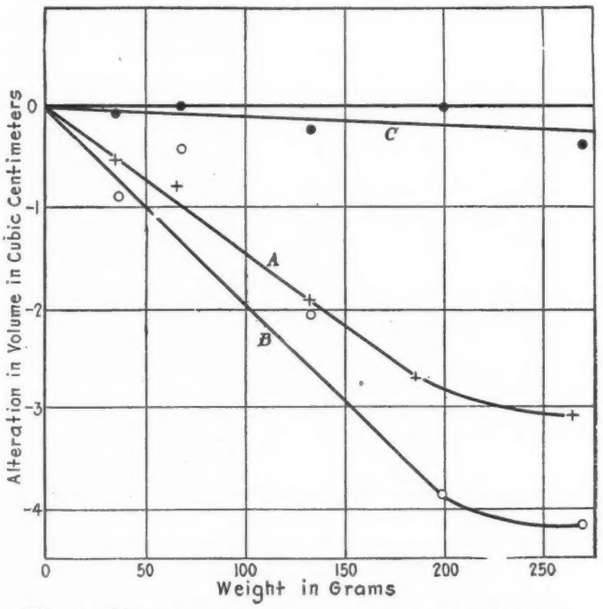


Fig. 3—Alterations in volume of quenched cylindrical specimens

original diameter (0.9003 in.), and the increase or decrease in diameter varies as follows from end to end:

Length in.	Final dia. of last end to enter water, in.	Middle, diam., in.	Dia. of entry end, in.
0.525	0.8997	0.9001	0.9018
	0.8986	0.9004	0.9017
1.0157	0.9002	0.9013	0.9027
	0.9008	0.9020	0.9028
2.0006	0.8994	0.9007	0.9020
	0.9008	0.9002	0.9030

In horizontal plunging the circumference shrinks as follows:

Length in.	Final dia. of last end to enter water, in.	Middle, diam., in.	Dia. of entry end, in.
0.525	0.8953	0.8950	0.8965
1.0193	0.8960	0.8950	0.8952
1.0193	0.8965	0.8953	0.8950

Flat plate plunging experiments

Another test was that of the dowel plate shown in Fig. 5, which was cased for three hours at 850 deg. C. and then quenched at 750 deg. C. by plunging it into water with its wide surface at right angles to the surface of the water. A second plate was then quenched by plunging

into water with its wide surface parallel to the surface of of the water. This is not a method that would be adopted practically and the surface was rounded in the direction of the length but not that of the width. The following average alterations in dimensions took place:

	Vertical plunging	Horizontal plunging
Length change	+0.0016 in.	—0.0017 in. (not reliable)
Width change	+0.0014 in.	—0.0089 in.
Thickness change	+0.0037 in.	+0.00235 in.

Some important deductions may be made from those tests: It can be shown that if a cylindrical object is

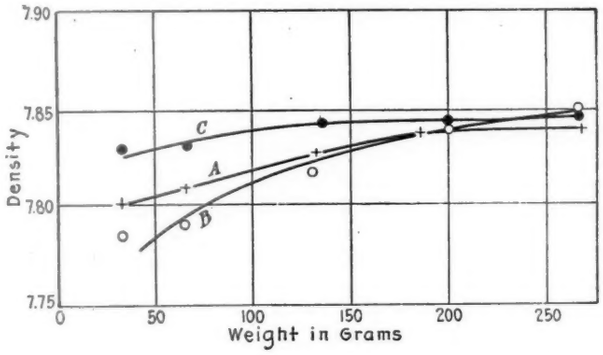


Figure. 4—Alterations in density of quenched cylindrical specimens

plunged horizontally the diameter shrinks, and under certain conditions if vertically plunged, it tends to increase.

The quenching deformations are produced in the initial period; modification continues, augmented by the speed of cooling, during cooling, while the resultant internal stresses must depend on the quenching deformations.

Solid cylinders plunged vertically

In the vertical plunging of solid cylinders the deformation brought about in the initial period is a swelling of the rim, which causes at a later period a local thermal stress, and its effect is sometimes seen when a small ring separates from the rest of the cylinder. In hardening milling cutters this is gotten rid of by adding a blank of the same diameter to take the first quenching shock.

It might be thought that as soon as the red-hot surface

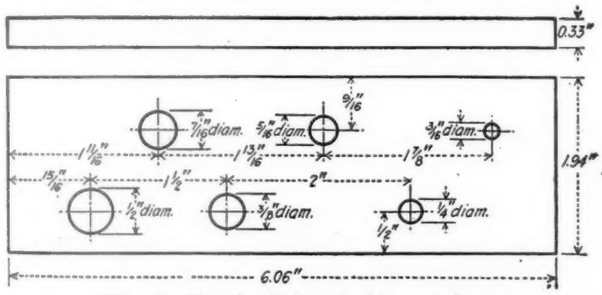


Fig. 5—Sketch of dowel plate specimen

touched the water there would be an instant generation of steam, but there was not. This belief in the spontaneous generation of steam prevails especially with regard to boiler explosions which have taken place owing to a failure of the feedwater supply, which has ultimately allowed the boiler crown to get red hot. These tests, however, disproved this idea.

It is difficult to discover the conditions for cooling, but the hardened ring mentioned above gives a clue. It is obvious that after the specimen has transmitted to the water sufficient heat to bring it up to or past the boiling point, it can absorb no more, and that the water which has previously been wetting the specimen will turn into steam. The general conception is that the cooling goes on equally on all the wetted surfaces and such an idea is necessary on any mathematical theory.

According to McCance, "on immersing a uniformly heated bar in water at zero deg. C., the first thin layers of water in contact with the surface of the bar are rapidly heated to their boiling point and steam is formed which, expanding outward, causes a fresh layer to come in contact with the surface, the process being repeated. The surface of the bar alternates between zero and 100 deg. C. while the steam acts as a carrier of heat to the body of of the liquid. This goes on until the supply of heat is insufficent to form steam, when the transference of heat to the cooling of the bar takes place by convection only.

Further, a hypothesis dealt with by Fourier assumes that there is a sudden cooling of the surface to final temperature or presupposes a quenching with an infinitely rapid cooling medium; in fact, any mathematical theory must consider a uniform cooling of the surface.

From a study of streamline motion it is easily realized that uniform cooling of the surface is not possible, and the problem has been attacked by allowing flowing water to pass various rectangular and cylindrical objects and studying the various streamlines. Similar forms have then been made in which the exterior is formed of fine

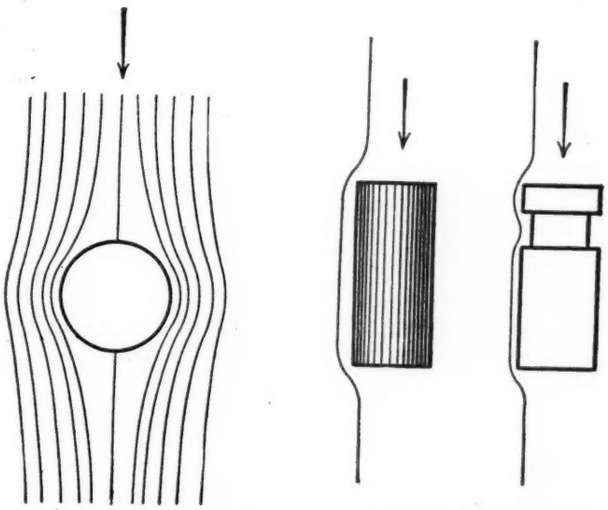


Fig. 6—Left, Streamlines around an infinitely long cylinder lying in water with the axis horizontal; Right, Showing one streamline in the position obtaining for vertical quenching

high-resistance wire. Steady conditions were obtained with the cold form and the streamlines studied under normal conditions, then the current was switched on and they were studied under the new conditions.

The right hand drawing in Fig. 6 shows one streamline for cylinders in the same position as obtained in vertical quenching. With an infinitely long cylinder lying in the water with its axis horizontal, the streamlines would theoretically be as shown in the left hand drawing of the same figure. These figures show that the streamlines are totally different for the two cases, and it has already been shown that the distortion is different.

Thin circular disk

Another illustration might be taken: Supposing that a thin circular piece is being plunged through the still quenching medium, the streamlines will be as shown in the right hand sketch of Fig. 7. In the center the whole of the momentum will be converted into pressure energy, while toward the edges a greater part will be converted into velocity energy.

It has been proved that streamlines are the same when flow takes place past a fixed obstacle as when the obstacle moves at the same speed as the stationary fluid. Further, the type of flow taken on the under side of the object depends on the velocity. If it is more than 30 cm. per sec. then there will be turbulent flow; 30 cm. per sec. is roughly 1 ft. per sec., and it has been shown that it is possible to get a quenching velocity of 6 ft. per sec.

If the velocity is diminished to under 2 cm. per sec. or 0.0656 ft. per sec., the surfaces of discontinuity disappear and are succeeded by a central turbulent ring together with two vortices.

When the thin rectangular form is stationary and there is a slow velocity of flow past the form, the streamlines

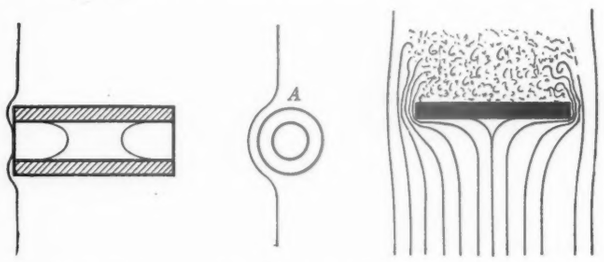


Fig. 7—Left, in quenching heated specimens the two pistons of hot water preceded by steam tend to reduce the diameter at the center; Right, Streamlines around a thin disk being plunged through a still quenching medium

The center sketch is drawn to show that if the specimen sinks at the rate of more than 1 ft. per sec., turbulent flow takes place at the side *A* and steam accumulates at this point first.

are as shown in the left and right hand sketches in Fig. 8, but immediately the form is heated the lines reverse in direction as shown on the left of the same figures. The heat passes to the water on the underside by conduction and the water is only heated for a very short distance. This is illustrated by the original streamline being cut as at *AB* in the right hand sketch, Fig. 8, and remaining persistent for some time.

It will thus be seen that as soon as the current is switched on the streamlines change direction, and the hotter the form the more they tend to become sinuous.

In actual plunging the turbulent flow set up with velocities of over 1 ft. per sec. and shown in the right hand sketch, Fig. 7 will be intensified by the red-hot metal, but as soon as the surface has dropped in temperature it will tend to become as shown on the right of the right hand sketch, Fig. 8.

Streamlines around a stationary cylinder

Take again the case of the streamlines around a stationary cylinder (Fig 6, left) if the velocity is over 1 ft. per sec., turbulent flow will take place on the downstream side of the body, and will be spread over more than half of the underside of the circumference. With drastic quenching and a stationary liquid this will be on the top side (Fig. 8, center). It therefore follows that steam will be more freely generated on this side, keeping one part of the circumference hotter than the other and allowing greater shrinkage of the high-carbon-steel shell. Take the tests in the table:

Case-hardened cylinders plunged with the horizontal axis parallel to the plane of the water

Avg. dia.	Avg. length	Change of dia.	Change of length
0.8973	0.89927	—0.0001	0.0009
0.8972	1.8955	—0.00023	—0.00063
0.89723	2.89932	—0.00025	—0.00205

(Note that length practically equals diameter, giving more surface for a given volume.)

Case-hardened cylinders plunged with the horizontal axis at right angles to the plane of water

Avg. dia.	Avg. length	Change of dia.	Change of length
0.9002	0.89972	—0.00033	+0.0006
0.9000	1.8974	+0.00033	+0.00117
0.9000	2.89665	+0.00016	+0.00122

(See above note.)

With drastic vertical quenching when the length is more than three diameters long, eddy formation takes place around the edges of the base which first meets the stream, followed by streamline and eddying water in the wake. The stream in this case has more chance of being swept away, hence there will be rapid cooling of the shell.

Hollow cylinder plunged vertically

Another case which is obvious is that of a hollow cylinder plunged vertically, that is, with the plane of the hole parallel to the plane of the surface of the water. It is known that rings above 3 in. in diameter open out, become larger, and it is therefore necessary for the lathe operator to make the ring smaller in diameter to provide for a grinding allowance.

The maximum and minimum allowances for rings up to 8 in. in diameter may be found from the following rules:

$\pm$ Maximum allowance to be added to standard size $= 0.05 \log D + 0.015$

$\pm$ Minimum allowance to be added to standard size $= 0.04 \log D + 0.01$

where D = internal diameter of the ring.

It will be noted that with the small rings no allowance

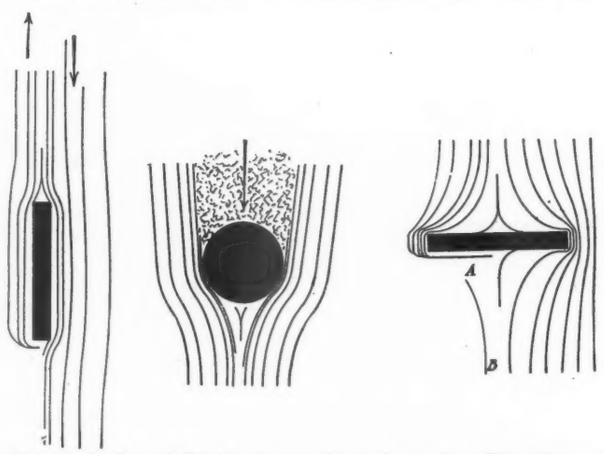


Fig. 8—Left and Right, Streamlines Around a Thin Rectangular Form; Center, Turbulent Flow with Drastic Quenching

is necessary, the ring coming in and providing its own grinding allowance, the first quenching for the inside being hot water preceded by steam.

For an 8-in. ring the above rules give:

Maximum allowance $= 0.05 \log 8 + 0.015 = 0.060$ in.

Minimum allowance $= 0.04 \log 8 + 0.01 = 0.046$ in.

That is, the lathe operator must turn between the limits 7.96 in. and 7.954 in. in order that outward distortion and grinding may be provided for.

From a series of experiments carried out by the author on 8-in. and 5-in. rings carburized at 900 deg. and quenched at 850 deg. C. and by Blue on ½-in., 1-in., 1½-in., and 2-in. rings carburized at 926 deg. C. reheated to 888 deg., quenched in oil, tempered at 792 deg. C. and quenched in water, the following rule has been deduced:

$$\text{Distortion} = -0.00037D^2 + 0.0068D - 0.0163$$

The actual distortion on an 8-in. ring from this rule is 0.0145 in. It must of course be remembered that the higher the quenching temperature, the greater the distortion.

The distortion of small rings is due again to the difference in temperature of the quenching water on the inside and outside of the cylinder and the resulting thermal stresses produced.

In quenching screw gages, they are plunged vertically at comparatively slow velocities. The streamlines which run near to the crest of the thread of a screw are deflected slightly inward toward the core and then outward to the next full diameter, but this can be observed experimentally only on a screw with a big pitch. The full and effective diameter will be cooled first. The core will be shielded by hot water and steam and must cool more slowly, and shrink, owing to the heated mass of the body of the gage. The following results illustrate this point.

		Before hardening	After hardening	Change	Remarks
Full diam.	F	1.1491	1.1516	+0.0025	Entry end
	M	1.1492	1.1513	0.0021	
	B	1.1491	1.1518	0.0027	
Effective diam.	F	1.1176	1,1203	0.0027	Entry end
	M	1.1176	1.1191	0.0015	
	B	1.1175	1.1196	0.0021	
Core	F	1.0848	1.0874	0.0026	Entry end
	M	1.0848	1.0862	0.0014	
	B	1.0848	1.0862	0.0020	

Generally, in the tests given in this paper, shrinkage is only occasionally experienced in the core and depends on the pitch.

	Before hardening	After hardening	Change
Full diameter	1.3071, 1.3075	1.3077, 1.3079	+0.0006, +0.0004
	1.3075, 1.3070	1.3082, 1.3081	+0.0007, +0.0011
	1.3072, 1.3075	1.3085, 1.3081	+0.0013, ±0.0006
Effective over needles	1.3250, 1.3255	1.326, 1.3264	+0.0010, +0.0009
	1.3235, 1.3235	1.3244, 1.3245	+0.0009, +0.0010
	1.3237, 1.3233	1.325, 1.3241	±0.0013, +0.0008
Core over pieces	1.5340, 1.5336	1.5335, 1.5336	+0.0005, 0.0000
	1.5339, 1.5340	1.5337, 1.5340	—0.0002, 0.0000
	1.5339, 1.5337	1.5341, 1.5339	+0.0002, +0.0002

As additional proof, a ¾-in. diameter cylinder 3 in. long was prepared and threaded the entire length with a U. S. standard thread, 10 per inch. The actual rate of center quenching calculated at the cooling velocity of 720 deg. per sec. was 92 deg. C. per sec. against 90 deg. for a similar plain cylinder. The surface per unit volume of this threaded specimen and of an unthreaded cylinder of the same length and diameter were respectively 11.0 and 6.0.

The streamlines or the convection currents are the factors in quick cooling producing initial deformation. Spaces which allow warm water, steam, or air to accumulate must delay cooling. A series of tests were carried out by cutting a free screw thread on the outer surface of a calorimeter tube with the object of breaking up the flow of water and thus increasing the rate of heat transmission. In another series the tube surface was not so broken. Comparing results, it was found that the rate of heat transfer is not appreciably altered, probably due to the bottom of the thread being filled with nearly stagnant water, which neutralizes the good effect produced by the water scrubbing hard over the tops of the thread.

In a paper by K. Heindlhofer, it is pointed out that comparison of the experimental curves with solutions obtained mathematically bears out the fact that the hypothesis in which it is assumed that steam is formed at the boundary of the solid (Leidenfrost effect). That the water-steam surface remains parallel with the surface of the solid and that heat moves in the liquid by conduction alone is untenable after the first stages of quenching.

Neither is the hypothesis valid that steam is formed at the bordering of the solid, and that the surface water-steam remains parallel with the surface of the solid; heat is removed by convection only at a uniform rate.

This is explained by the fact that the thickness of the steam film grows rapidly, becomes unstable, and bubbling is set up.

From a study of the streamline effect in connection with the dimensional changes of a case-hardened specimen, it is most probable that there is a tendency for the steam to form in bands, along planes where the direction of flow is a minimum or where eddying is set up.

It is obvious that the casing of, say, 0.9 per cent carbon steel will tend: With almost instantaneous surface cooling to give an increase of volume; With slower surface cooling to give a decrease in volume; With a band of steam, say on the longitudinal surface of a cylinder plunged as shown in Fig 8, center, to give a decrease in volume.

In conclusion, it is evident that there has been little progress in many shops as far as quenching operations are concerned. A tank of some type with a means of keeping the water cool is looked upon as all that is necessary.

It is extremely likely that not only will spray cooling be provided, but also cooling with sprays of appropriate temperature or with jets of different types and temperatures.

A tool rack for the smith shop

SHOWN in the illustration is a swivel rack for holding hammers and other tools. It was designed primarily for use in the blacksmith shop but it can be used in any shop where a number of such tools are used. The

A convenient and good looking rack for holding hammers and miscellaneous tools

swiveling arrangement makes the rack especially handy as it is only necessary to turn the rack within reach of the tool desired. It was designed and built by the blacksmith standing at the left of the rack.

Staybolt production in railway shops

The proper threads, inspection system, gages, fixtures and machines best suited for this work

Part I.

IN the minds of many railroad men, it is a question as to whether staybolts should be purchased or manufactured in the shops. It is doubtful, however, if the manufacture of staybolts in railway shops will ever be entirely abandoned, owing to the many diameters and lengths demanded on short notice in locomotive repairs. A skeleton organization, at least, must be maintained for this work. The question of purchase, ordering from a central shop or local manufacture, must, from necessity be determined by each railway.

There has been considerable discussion as to the most desirable shape of thread, the best practice for measuring the diameter of the threads and the permissible error of lead of the staybolts. As the above

Fig. 1—Left: Sharp vee thread—Center: United States Standard thread—Right: Whitworth standard thread

factors govern largely the commercial manufacture, the question of gages and devices will first be considered.

Shape of thread

Staybolts are made with either one of three forms of thread shown in Fig. I. The sharp vee thread is sup-

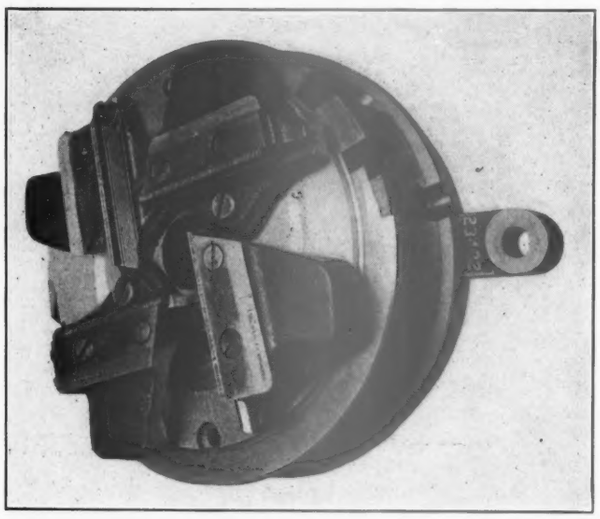


Fig. 2—Reverse taper die lead and chasers for cutting threads on staybolts

posed to have a nearly or entirely sharp top and root. The U. S. form of thread has the top and root flattened one-eighth of the pitch. This form is almost universally used in this country for bolts and screw threads. The Whitworth form of thread has a rounded top and root, which is the English standard. It is a question if any person other than the most expert can tell from the appearance which of the three thread forms has been aimed at when the staybolts are cut with regular commercial bolt cutting chasers.

The vee threads are supposed to have a sharp or knife edge at the top and root and a 60-deg. included angle. In actual practice, the sharp top and root can not be maintained owing to manufacturing difficulties. If it were possible to make the chasers to the theoretical shape, the sharp top and root are not obtained when threading owing to the metal dragging during this operation. Therefore, the thread will more nearly resemble the Whitworth form. As there is no standard for pitch diameter of the vee form of thread, this form is gradually being done away with.

The U. S. form of thread theoretically has a flat top and root measuring one-eighth of the pitch and a 60-

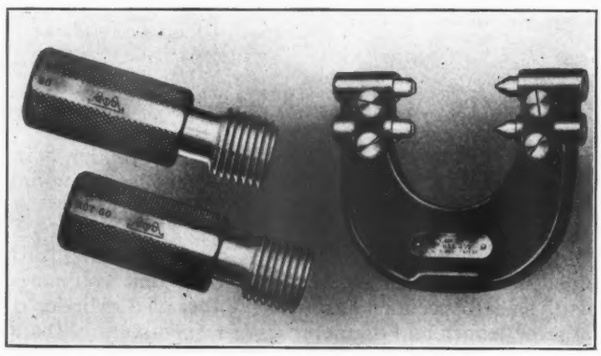


Fig. 3—A Greenfield thread limit gage and master gages used for the inspection of staybolts

deg. included angle. The amount of flats for 12 threads per inch is .0104 in., or practically .010 in. A glance at a scale graduated to 100 divisions per inch or, if not at hand, a 1/64 in. scale equalling .0156 in., will serve to illustrate the small amount of the flats. It is a question if staybolt threads in actual every day practice are ever cut to the true U: S. form, owing to the metal dragging and producing a rounded top and root.

The Whitworth form of thread is rounded on the top and root and has a 55-deg. included angle. With this form of thread, a staybolt may be cut closer to the prescribed form and, from a strictly theoretical point of view as far as the shape of thread is concerned it is satisfactory. However, from a staybolt manufacturing point of view it has certain objections owing to the difficulty of manufacturing the taps and dies to the correct shape.

From the above, it is evident that staybolts cut to either of the three forms of threads will have similar appearances. Therefore, the form more suitable from a bolt shop, boiler shop and a tool room point of view, should be selected.

The U. S. form of thread is gradually replacing all

other forms for staybolt work as it has the following advantages in its favor:

(a) The pitch diameter standards are well established.
(b) It has the approval of the tap manufacturers and the Thread Commission of the United States Department of Commerce.
(c) The thread sizes are quickly measured, making it economical to measure staybolts whether made by the railways or purchased.
(d) By adopting one standard it reduces the varieties of staybolts carried in stock by manufacturing concerns, therefore encouraging their manufacture by outside concerns.
(e) It reduces the staybolt taps to one common form of thread, making it possible for the manufacturers more quickly to fill orders.

Pitch or lead of thread

Twelve threads per inch is the generally accepted standard for staybolts. There has been considerable controversy as to the amount of deviation that should be allowed from a true 12-thread-per-inch lead. Some railways insist on great accuracy and demand that all staybolts be cut on machines equipped with lead screws similar to the lead screw on laths to insure correctness. Others are willing to rely on the chasers for the correctness of the lead. It is not the purpose of this article to go into the question of the allowable error in the lead of staybolts. An investigation will generally reveal the fact that the lead for the tapping of boilers from the outer to the inner sheets is subject to so many variables that refinements of the thread lead to staybolts is largely lost. For instance, it is the practice,

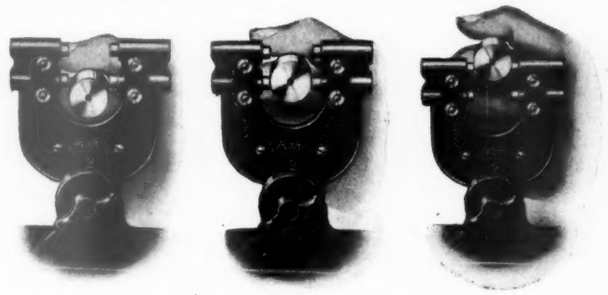


Fig. 4—A Greenfield limit gage held in a vertical position to gage the bolt by its own weight

when tapping boilers, to drive the staybolt taps with air or electric motors which may be held at any angle. When tapping downwards, the weight of the motor is on top of the tap which tends to spring or move the first sheet towards the second. At other times the conditions are reversed. One gang of men will apply more pressure, others less, springing the sheets in different amounts. The firebox is often only temporarily held in place where a slight irregularity in the method of tapping affects the lead of the tapped holes. All these varying conditions tend to destroy the accuracy of the lead between the two sheets. Under most conditions even where the entire boiler is tapped with the same tap, the lead from the outersheet to the firebox is not the same for all holes. It would, therefore, appear that too great a refinement in correct thread pitch lead of the staybolts is largely lost owing to incorrect tapping of the boilers. It is, therefore, believed that where the staybolts are threaded with chasers in good repair, they will meet all conditions as far as the threads per inch is concerned.

Error in the lead of staybolt taps

As a general proposition, when manufacturing staybolt taps, the greatest cause of error in the lead results from the hardening which is a condition difficult to control owing to different steels not acting alike during the operation. The manufacturers in conjunction with the Department of Commerce have set .003 in. as the maximum allowable error in the lead for each one-inch of tap. This limit is readily lived up to. To ask for a greater refinement only adds to the cost without compensating advantages.

Errors in staybolt threading

When threading staybolts without the use of lead screws the most common errors in the lead may be caused by the following:

(a) Incorrect closer leads, which may have been caused by defective hobs used when hobbing the chasers, or during the hardening operation.
(b) Chasers that have been ground too far back from the throat, allowing only a few threads for leading the bolt.
(c) Carriages on bolt threading machines for holding the bolt too heavy, or not working freely on the ways, causing the bolt to drag and increase the lead.

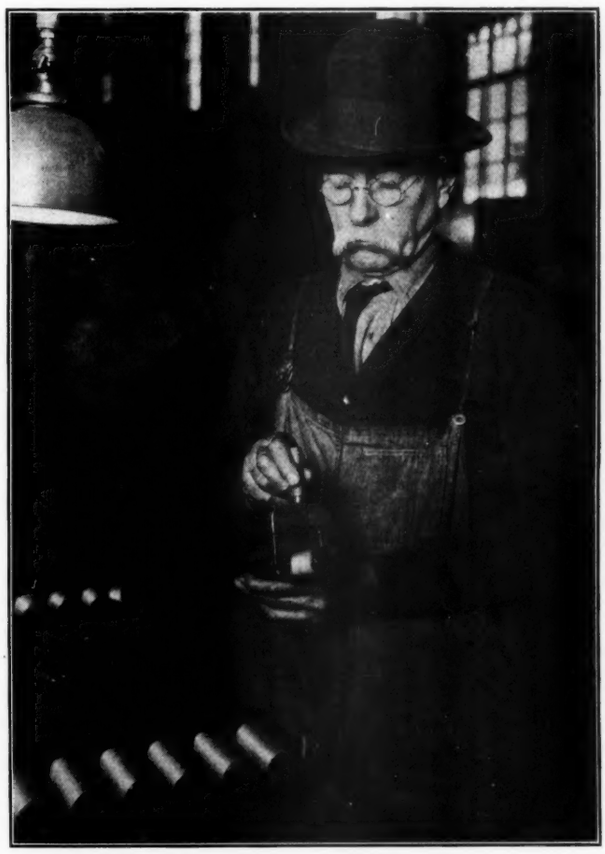


Fig. 5—Inspecting staybolt thread sizes with limit gages

A remedy for the first trouble is to insist that all chasers be held within the maximum error of .003 in. per inch of tap. A general remedy for the second is to use only full width chasers. When it is necessary to sharpen the chasers, grind only on the face or ends and do not reduce the width. In many respects chasers as shown in Fig. 2 with the threads milled on their sides are more desirable for staybolt work owing to the fact that they may be ground without altering the shape of the cutting edge, also the rake of the cutting edges can be ground as best suited for the metal to be cut. For bar iron, the front rake may be seven degrees, for soft steel possibly ten degrees.

Economical manufacture, ease of applying and satisfactory service has shown that staybolts should be threaded close to standard sizes and within certain limits in order to admit of applying any bolt of the same nominal diameter to any tapped hole of the same nominal diameter. To set the limits too close adds to the cost of manufacture. The absence of proper limits results in the improper fitting of bolts. The happy medium is limiting the sizes close enough to meet the requirements without throwing too great a burden on the shops when inspecting or adjusting the chaser dies. Furthermore, the shops should be provided with gages by which the thread sizes of the bolts may be gaged in the minimum time. The practice in some railroad shops is to gage each individual bolt at the time of manufacture and a second time by the bolt inspector. This practice results in maintaining thread sizes which

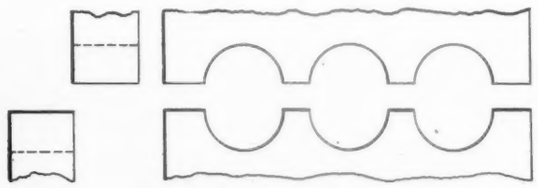


Fig. 6—Staybolt blanks are sheared at each end with these dies

admits of applying the bolts in any shop on the system. This practice is essential for central production shops.

Gaging the pitch diameter of staybolts

It is now universally recognized and approved by The Bureau of Standards that the only correct method for measuring the diameter of threaded articles is on the pitch line. (The term pitch line, or pitch diameter indicates a line about midway between the top and root of the thread.) The pitch diameter for each diameter of bolt threads per inch are shown in numerous text books and trade catalogues. Table I shows the pitch diameter for 12 thread U. S. form and Whitworth staybolts of the sizes commonly used.

The pitch diameter of staybolts and staybolt taps are readily measured with thread micrometer calipers. One common form is shown in Fig. 3. These instruments are useful for the measurement of all sizes of threads and should form a part of the tool room equipment of all railroad shops. Staybolts, with certain exceptions, are threaded smaller on the pitch diameter than the basic sizes shown in Table I, in order that they may readily screw into the boiler. However, no

Table 1—Maximum or basic pitch diameter and minimum pitch diameter based on a working limit of .004 in.

Diameter		U. S. F. pitch dia., inches		Whitworth pitch dia., inches	
Bolt	Inches	Basic	Min.	Basic	Min.
3/4	.750	.6959	.6919	.6967	.6927
13/16	.8125	.7584	.7544	.7592	.7552
7/8	.875	.8204	.8164	.8217	.8177
15/16	.9375	.8834	.8794	.8842	.8802
1	1.000	.9459	.9419	.9467	.9427
1 1/16	1.0625	1.0084	1.0044	1.0092	1.0052
1 1/8	1.125	1.0709	1.0669	1.0717	1.0677
1 3/16	1.1875	1.1334	1.1294	1.1342	1.1302
1 1/4	1.250	1.1959	1.1919	1.1967	1.1927

Pitch diameter of U. S. F. thread is .0541 in. less than nominal diameter.
Pitch diameter of the Whitworth thread is .0533 in. less than nominal diameter.

hard and fast rule has been definitely established for the minus limits. Balancing the threading against the fitting in the boiler sheets has shown that the pitch diameter should come between the basic sizes minus .004 in. as shown in Table I.

Thread gages

To insure the correct thread sizes of staybolts, it is necessary to provide the machine operators with thread limit gages which must be easy to apply and require the minimum time when testing the threads. Fig. 4 shows a work thread limit pitch gage which has been found sufficiently accurate and quick to apply. The gage has two maximum or "go" points and two minimum or "not go" points, which are of a shape similar to the thread; viz, 60 deg. included angle. The gage is at times held vertically in a holder as shown in Fig. 4. When testing with the gage in a vertical position, the bolt is laid on the upper "go" points and if within the limits, passes through by its own weight but does not pass the lower "not go" points. In the event of the bolt not passing the "go" points, it shows that the thread is too large, which means that the bolt has to be rethreaded. In the event of passing the "not go" points, the bolt is rejected. In some cases, the gages are held in the hand as shown in Fig. 5. The time required for testing is principally that of handling the bolts. When considering the great improvement in the uniformity of the thread sizes following the use of these gages and the small amount of time consumed for testing, this method of staybolt inspection is a good practice which results in economy for any railway shop. Fig. 3 shows a master cylindrical gage used when setting the work gages. The work gages are frequently checked and when necessary, reset to the master gages.

Two designs of heads for crown staybolts are in common use. These are the straight threaded with button heads and the taper threaded. When threading the head end of the straight bolts, it is advisable to make use of a separate thread limit gage as shown in Fig. 3 with the minimum or "not go" points set to the basic size shown in Table I. The maximum sizes are set .004 in. larger. The head end of staybolts threaded to the gage will be about .004 in. larger than the usual staybolt with the result that they will screw tight into the firebox sheet and generally make a tight joint.

Some railways prefer the taper thread on the head end of crown staybolts in which event a limit gage is

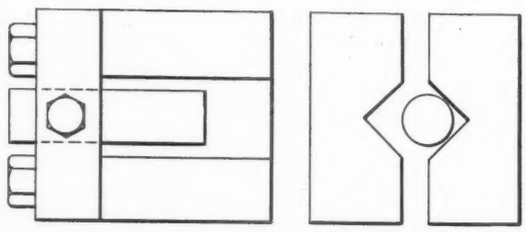


Fig. 7—A die for the cold forming of square ends on radial staybolts

used. The master and work gages are set preferably for the larger end of the taper thread.

Staybolt manufacture

A number of ingenious devices have been developed in railway shops for the economical manufacture of staybolts. The following descriptions are confined principally to what appears to be the most advanced practices for each operation.

Shearing the blanks—One common practice is to shear the blanks to the required lengths in guilotine shears. The cutting blades used are shaped as shown in Fig. 6. The radius of the openings is about 1/64 in.

larger than the bar stock, which admits of shearing with the least distortion of the blank ends. The bars are fed up against a stop attached to the shear which admits of cutting one, two or three bars at one time.

Squaring the ends—For the purpose of driving staybolts when screwing them into the boilers, a number of practices are followed such as forming a square on one end to fit a wrench, driving the staybolt with an eccentric clamp which grips the round surface of the bolt, or threading the entire length of the bolts in which case a threaded socket wrench is used.

Cold squaring is preferably done on powerful toggle joint presses such as used in the mints for coinage purposes. The dies have square vee grooves as shown in Fig. 7. A stop is located between the dies for gaging

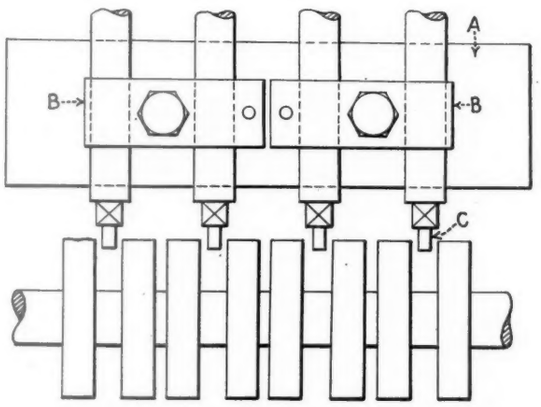


Fig. 8—A fixture for milling the square ends on four staybolts at one set-up

the distance the blanks enter. When squaring, the press runs continuously. The blanks are laid on the lower die and against the stop and as the top die descends, the ends are squared. While the squares are not perfectly formed, they answer the purpose. The press makes about 100 strokes per minute therefore the production is high. There are, however, minor objections to this method. The squared ends are not always true with the blanks which, at times, results in their running eccentric during the threading operation resulting in the chasers cutting a greater amount on one side of the blank, thus making a deep thread on one side which is incomplete on the opposite side, showing the black scale at the top of the threads. This is largely overcome by the use of a floating drive for the bolt at the time of threading.

For squaring in a forging machine, the forging dies are quite simple. The two gripping dies have half round grooves of suitable size to grip the bar similar to bolt dies. The plunger has a square hole of the correct size for forming the square. The blanks are heated, placed in the machine and headed. With the machine and dies in good repair, the squaring is in line with the blank. However, care is necessary in order to obtain the desired results. The objections are the cost of fuel for the heating as well as labor costs and changing the dies for different sizes. Where the expenditure for a special press is warranted, it is more economical to cold press the square ends.

Squaring on milling machines—In many respects, the most desirable practice is to mill the ends square. Numerous designs of holding fixtures for work of this nature have been designed, some very elaborate with indexing attachments, some without. Fig. 8 shows a fixture on which four blanks are held in vee grooves cut in the top face of the lower member *A*. In operation, four blanks are placed in the grooves, the distance being gaged by the stop *C*. The top clamps *B* are tightened securely, holding the blanks. Eight milling cutters are mounted on one arbor.

After milling the two sides on each of the four blanks, the clamps are loosened, the blanks given a quarter turn and the clamps tightened after which the other two sides are milled. The operator can generally turn the blanks and gage the second setting by the eye sufficiently accurately to meet all the requirements for work of this nature.

Owing to the sharp corners resulting from milling, it is only necessary to square about ½ in. of the blank, which is sufficient for the socket wrench on a finished surface of this nature. As the milling feed can readily be 4 in. per min., the actual time, plus the run-over is about 15 sec. for each milling operation, or, when including the loading, the time for each blank is about 20 sec.

Milling the ends of staybolts has the following advantages:

(a) The squares will be central with the blank which will reduce the chances of improper threading

(b) Less length of stock is required, as the thread can be run closer to the squared ends.

(c) The time and expense compares favorably with forging.

Staybolts threaded their entire length—In some shops in place of squaring the ends, they are threaded their entire length and cut off to proper lengths ready for the beading operation. When screwing into the boilers a threaded socket wrench is used for this purpose. As squaring is not necessary, their manufacture will be explained later on.

Threading staybolts

Staybolts are threaded on one, two and three-spindle bolt cutting machines, some equipped with lead screws and some without; also on vertical spindle special purpose machines. The ordinary bolt threading machines

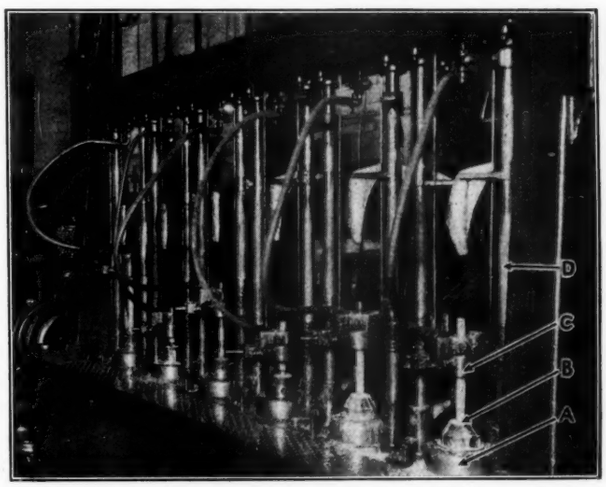


Fig. 9—Cutting the threads on three different sizes of staybolts on a six-spindle threading machine

used for this purpose are too common to require explanation. The principal requirements for the work are that the machines have free moving carriages and good cutting chasers.

The vertical staybolt threading machines are less common and will, therefore, be briefly explained. One

type shown in Fig. 9 which has six spindles, each of which is driven by bevel gears meshing into a common horizontal shaft located in the lower part of the machine. The bolts are driven by the square sockets *B* mounted on the upper ends of the spindles *A*. The adjustmentable self-opening die heads *C* are guided between the uprights *D*. After the completion of the threading operation of any of the spindles, the operator pulls a handle, one of which is shown at the left of the illustration, which raises and closes the die head. While the die head is held in this position, the previously threaded bolt is removed by the other hand and a new blank placed in the revolving drive socket. The operator gradually releases the tension on the spade handle, the die descends, when the blank is guided into the chasers and threaded, the die head opening at the lower point of travel.

In operation, the operator places the blanks in the spindles in one, two, three order, until all are full. Generally, when threading bolts about 7 in. long by the time the last spindle is loaded, the first bolt is completed. As a result, the threading operations are practically continuous. The threads are frequently tested with the limit thread gage previously described. In the event that the threads do not meet the limits, the dies are re-adjusted. By this careful inspection, the thread sizes are readily kept within the limits of the basic sizes and .004 minus. The output is governed by the ability of the operator to feed the machine, handle the blanks to and from the machine, inspect the bolts to insure the thread sizes coming within the limits, re-adjusting the dies, etc. Owing to the number of bolts undergoing the threading operation at one time the threading often exceeds the ability of the operator to feed the machine, with the result that the cutting speed is comparatively low to insure more perfect threads.

Flexible staybolts

Flexible staybolts are rapidly threaded on the above described machine. In place of the hollow square socket for driving the bolt, a socket or chuck suitable for driving the style common to the railroad is employed. As the threaded part of the bolt is comparatively short, the capacity of the machine is greater than the capacity of the operator to handle the bolts.

(The concluding part of this article which describes the manufacture of crown staybolts will be published in the March issue of this magazine—Editor.)

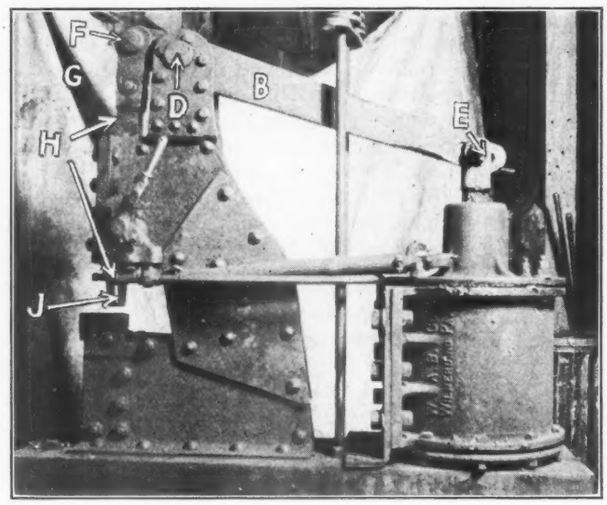
Portable pneumatic punch

By H. H. Henson

Machine shop foreman, Southern, Chattanooga, Tenn.

THE portable pneumatic punch, shown in the illustration, was built to expedite in the enginehouse the punching of holes in such repair jobs as cylinder cock rods, angle irons, patch sheets for locomotive tenders, etc. The punch is mounted on four wheels and can be moved about and put into operation wherever a connection can be made with the air pressure system.

The frame of the punch is constructed of 5/8-in. boiler plate riveted to a 2-in. by 2-in. frame. The punching lever *B* is actuated by a 14-in. by 12-in. air cylinder. The distance from the fulcrum pin *D* to the pin *E* is 20 in., and the distance from the pin *D* to the pin *F* is 5 in. A knuckle joint *G* is connected to the rod *H* to the lower end of which the punch is fastened. The distance from the center of pin *F* to that of pin *G* is 4½-in. The distance from pin *F* to punch holder *J* is 14 in. The air



A portable pneumatic punch for use in the enginehouse

supply is controlled by a Westinghouse straight airbrake valve. The punches, which vary in size from 1/8 in. to 5/8 in. can punch sheeets 1/2 in. thick.

Handy bending device for the boiler shop

THE illustration shows a handy device for bending small angles, channels or flat bars in the boiler, tank or car shop. Practically any degree of curvature

Device for bending small angles, channels or flat bars in the boiler or tank shop

may be obtained by substituting different shaped dies and adjusting the fulcrum pin to suit.

RADIAL DRILLS.—The American Tool Works Company, Cincinnati, Ohio, shows several examples of special designs in its 36-page catalogue descriptive of American radial drills. The triple purpose radial is described in detail.

View of plant showing boiler house, oil house, water tank, sanding towers and shop.

Electric locomotive maintenance

A modern electric locomotive repair shop is now in operation on the Virginian, at Mullens, West Virginia

By Allen McLanahan

Service engineer, Westinghouse Electric & Manufacturing Company.

IN CONNECTION with the electrification of 134 route miles of track from Mullens, W. Va., to Roanoke, Va., complete service on which was inaugurated in 1926, the Virginian erected a new shop for the maintenance and repair of electric locomotives. This is one of the few instances that a complete new plant, designed for the purpose, has been constructed in connection with an electrification.

Normally three units comprise a locomotive so that shop facilities had to be provided to care for locomotives measuring over 150 ft. in length. In considering the proper location for the electric shop it was desired that it should be not only the repair point, but as far as possible should be the turning point for all locomotives. Since the service requires that certain locomotives operate only at the western end of the electrification, on Clark's Gap Hill, the shop was located at Mullens, which is the western end of the electrified zone. All engines now operate out of Mullens and the necessity of maintaining a stock of spare parts at several points is eliminated. With this location the only additional shop facilities required are those for making the inspection and running repairs to locomotives at Roanoke after their eastbound trip.

General layout

From the accompanying plan layout it will be seen that the plant includes the shop proper, a storehouse, an oil house, a building for the substation and steam heating boiler, a water tank, sanding towers, an outside inspection pit and locomotive storage tracks. As all the tracks outside the shop are electrified, there is no need for a steam locomotive to move the electric locomotives.

On arrival from the road a locomotive passes between the sand towers, where the sand boxes and rheostat fresh water tanks are filled and the running gear washed. After this is completed it is moved on the same track to the inspection pit, where it receives a complete mechanical and electrical inspection. The trolley wire over this pit is equipped with a disconnecting and grounding switch so that the inspection of the pantographs and roofs can be made in perfect safety. After inspection, the locomotive is put on one of the storage tracks until it is again called. If repairs are to be made, the locomotive is pushed into the shop by another electric locomotive.

The water for shop purposes and for use in the liquid rheostats is obtained from a well located under the substation building. A deep well pump supplies this water to the 125,000 gallon storage tank from which it is piped to the shop and yard. For fire protection, a motor driven fire pump supplies water at high pressure to a pipe line to which fire hydrants are connected at convenient points in the shop yard.

The main shop

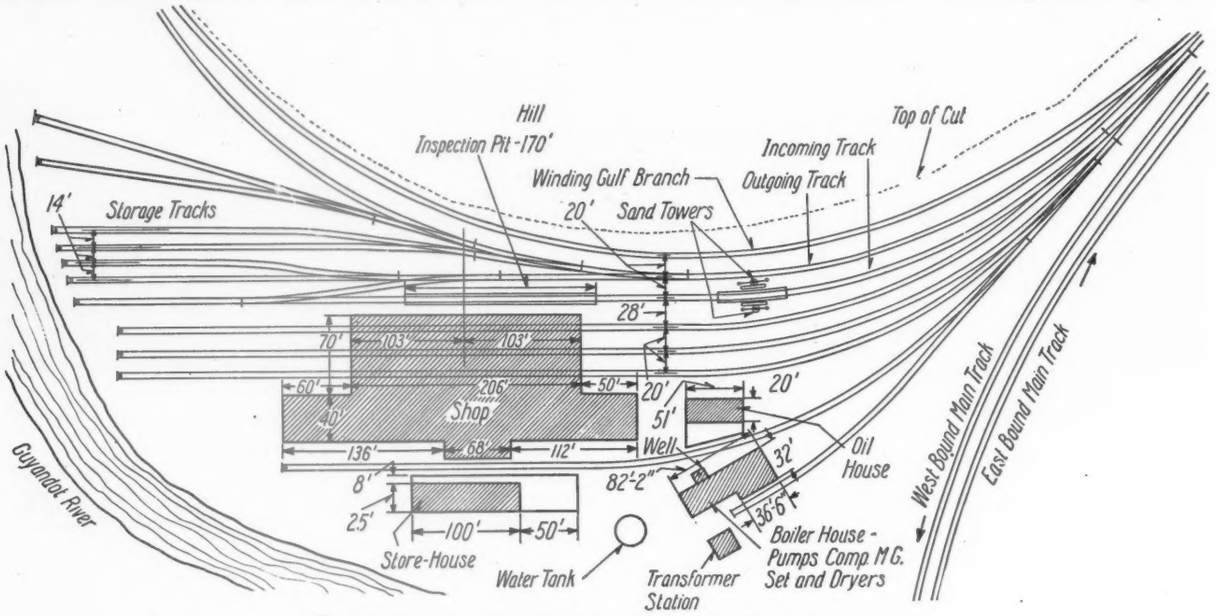
The main shop building has two bays and one wing which contains the carpenter shop, bake ovens and dip tank. The first bay or inspection building is 206 ft. long and 70 ft. wide and contains three pit tracks, long enough to take care of a complete locomotive. These pits have a jacking shelf and are equipped with permanent lights as well as receptacles for portable lamps and are piped for compressed air. There is a drop pit near each end of these tracks so that six points have been provided for dropping wheels and engine trucks. The drop pits are

equipped with portable hydraulic jacks. This bay is served by a 30-ton electric crane. A gallery has been provided along the outside track at the height of a locomotive roof for use in connection with pantograph or other roof work.

The second bay contains the tool room, air brake room, machine and blacksmith shops, winding room, electric

The 84-in. lathe is used for banding the large traction motor and phase converter rotors and can be used for turning the journals of the drivers if necessary.

The tool room, located in the center of the shop, is equipped with the necessary shelves for tools and special equipment and contains a 14-in. engine lathe and a universal milling machine. The carpenter shop has a



General layout of the Virginian locomotive inspection shops

repair spaces, locker and washrooms and the offices. This bay is served by a 15-ton electric crane, operated from the floor.

The floor of the whole shop consists of 2-in. treated oak planks laid on sills set in crusher dust. The shop is heated by an indirect system of unit heaters, each unit consisting of a steam radiator, electric blower fan and air piping. The ceiling is painted white and an ample provision of lights results in excellent illumination at night in all parts of the shop.

The whole shop is piped for compressed air, and outlets are located at convenient points for connecting portable lamps, the insulation testing outfit and a portable arc welding set. In addition there is a 32-volt a.c. circuit which supplies current to the locomotive lights without the necessity of using the batteries or energizing the locomotive. This arrangement is of great assistance in working inside the locomotive cabs as it obviates the necessity of taking portable lights into the cabs.

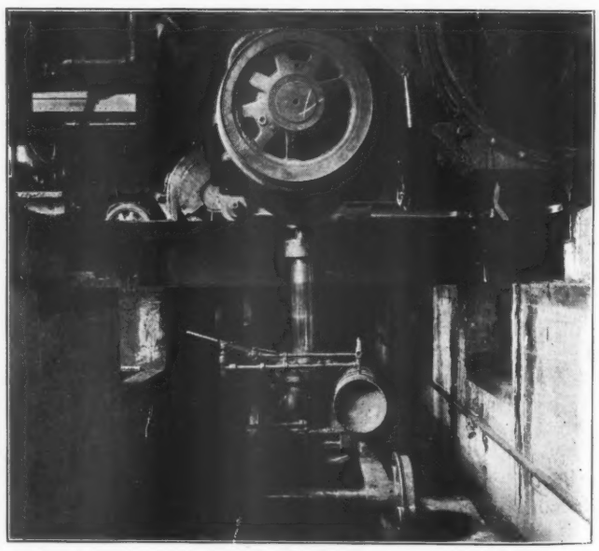
The machine shop contains the following machine tools, all of which have individual motor drive:

Size	Type
84 in.	Engine lathe
30 in.	Engine lathe
24 in.	Engine lathe
18 in.	Engine lathe
60 in.	Horizontal Universal boring mill
48 in.	Vertical turret lathe
32 in.	Crank planer with 40 in. stroke
40 in.	Shaper
26 in.	Slotter
36 in.	Radial drill press
28 in.	Vertical drill press
18 in.	Vertical drill press
———	Bolt Machine
4 in.	Pipe cutting machine

In addition there are two electric grinders, a 100-ton air operated bushing press and hand operated sheet metal shears, roller and crimper. No tire turning equipment or wheel press has been installed as it is intended that this work shall be done in the Princeton shops.

combination wood working machine, which consists of band saw, planer, rip saw and wood lathe.

In the blacksmith shop are two forges, one of which is used for babbitting work. These are supplied with air from a special motor driven blower. For heavy work there is a 600-lb. air operated hammer, the air being



There are six drop pits equipped with portable hydraulic jacks

supplied by a motor driven compressor which is integral with the hammer. An electric pyrometer is used in connection with the babbitting furnace to insure that the babbitt is poured at the proper temperature.

A separate room enclosed by a wire screen is used for

the repair and testing of air equipment. This room is furnished with benches, a test rack designed for testing the air brake equipment used on the locomotives and a special rack for testing magnet valves.

A gallery above the offices and locker rooms is used for the repair of the light electrical equipment of the locomotives, such as switches, magnet valves, relays and brush holders. Compressed air at 70 lb. pressure, as used in the control of the locomotives, is available at all of the benches. A separate room is provided for repairs to delicate relays and meters.

Drying and baking ovens

Two independent ovens especially designed for this purpose by the Westinghouse Electric & Manufacturing Company are provided for drying and baking the electrical apparatus. They are built of heat insulating material and are heated by electric heaters. There is a chamber above each oven equipped with a ventilating fan and dampers in order to provide a circulation of air through the oven during the drying. This has been found to assist this process materially.

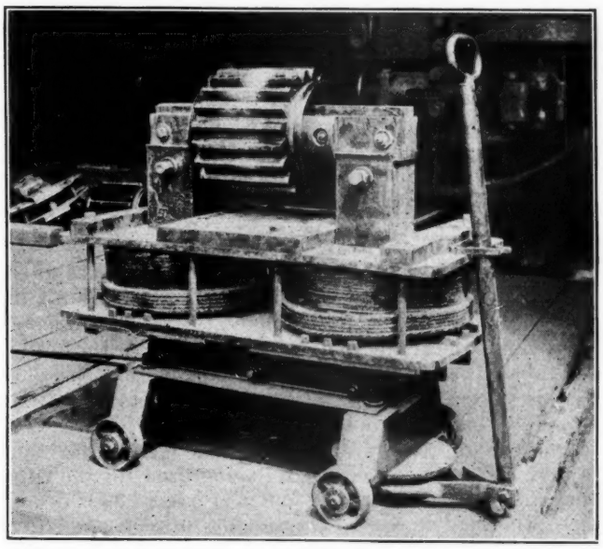
The temperature of the oven is automatically maintained between desired limits by a thermostat which operates the control of the electric heaters, and current is automatically cut off whenever the oven doors are opened. A record of the temperature is kept by Bristol recording thermometers. A voltmeter and necessary connections are provided for measuring the insulation resistances of the pieces of apparatus which are being dried out without opening the oven doors. These ovens, together with the dip tank are located in a wing of the main locomotive repair shop.

Dipping tank

In laying out the arrangement of the dip tank particular care was taken to minimize the risk from fire, owing to the highly inflammable character of the insulating varnish used for this purpose. The tank is located in a separate room, provided with fireproof doors and a ventilating fan to exhaust the vapor into the outside air. An emergency tank of the same capacity as the dip tank is buried below the latter. In case of fire a valve may be opened from the outside which will allow the varnish to flow by gravity into the emergency tank and thus extinguish the fire. Connections are made to this tank so that the varnish may be raised again to the dip tank by air pressure. The dip tank is also provided with a lid which will automatically close by gravity in case of fire.

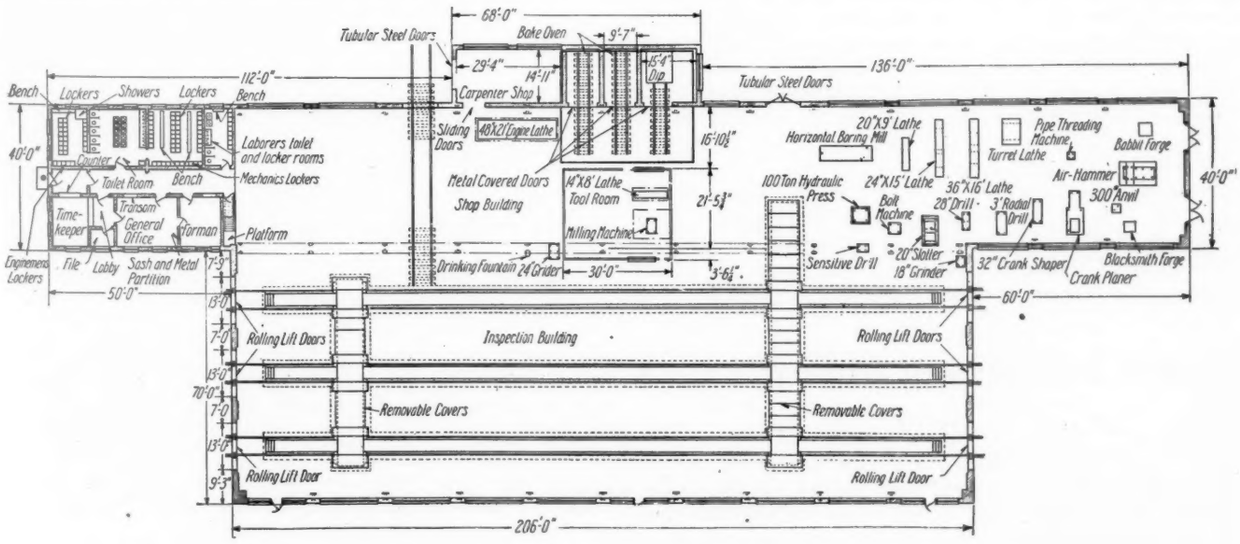
Storehouse and oilhouse

The storehouse building is 25 ft. by 100 ft. and has a large platform for unloading material and for the storage of castings and other material which does not require protection from the weather. The interior of the house is fitted with steel shelves for the storage of the various spare parts of the locomotives and other necessary material. It also contains an electrically operated water still which supplies all the distilled water that may be required on the road.



Portable electric pinion heater

The oil house is a separate building with a large platform for barrels and boxes of grease. It is fitted with tanks for oils of which small quantities are used and has measuring pumps connected to the underground tanks in which the large amounts of oil are kept. An air operated press for forming driving journal grease cakes and the grease sticks used in the main rods and for hub liner



Plan layout of the inspection building showing the location of the machine tools

lubrication is located here. A separate room at one end of this building is fitted up as a supply room where lanterns, flags, engineer's tool boxes and other locomotive supplies are kept.

Substation

Two Westinghouse 200-kw., 250-volt, single-phase synchronous motor-generator sets supply the 250-volt direct current for operating all the shop machinery and the lights. The power for driving these sets is obtained from the 11,000-volt trolley wires and the voltage is stepped down by two transformers, one for each machine located in an outdoor substation.

The substation room also contains a single stage, 12-in. by 10-in. air compressor which provides the compressed air for shop purposes. An emergency connection is provided for connecting locomotive compressors to the shop air system in case of a breakdown.

Special features

As the transformers used on the locomotives are of the oil insulated type, arrangements have been made for the purification of this oil. They consist of a Westinghouse oil treating outfit, located in the substation room, two oil tanks buried in the ground and pipe lines to the shop. By this system, the oil of all the transformers of a 3-unit locomotive can be completely purified in one day.

One end of the substation building is used for sand storage and drying, a coal stove being used for the latter purpose. The dry sand is put into one of two drums, each connected to one of the sanding towers, and raised to the towers by admitting air to the top of the drum. The two sanding towers are located one on each side of the incoming track. Each tower has three outlet pipes, spaced to accord with the openings of the locomotive sand boxes. This enables a unit to be completely sanded without movement. As the sand box openings are on the outside of the cabs, no sand enters the equipment room.

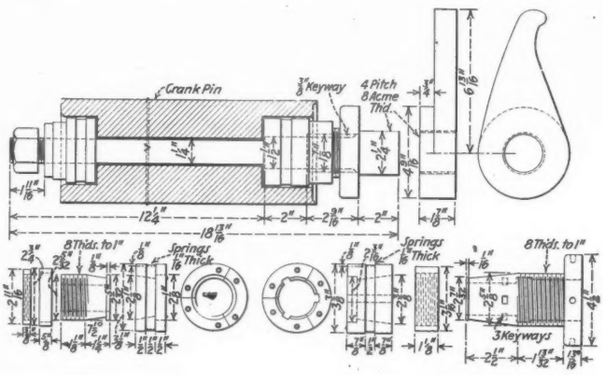
Among the new features in this shop are the two portable electric pinion heaters, made by the Westinghouse company. These are of the induction type, being really the primary of a transformer, the pinion itself being used as the secondary and being heated by the current which passes through it. By the use of these heaters the locomotive pinions are heated more rapidly and uniformly than is possible in an oven, about 35 min, being required to raise the temperature to 135 deg. C. which is the temperature at which the pinions are applied to the traction motor shafts. While these heaters were primarily designed for pinions, they are used for heating bushings and other rings which are to be shrunk on.

Since the shop has been in full operation the layout has been found completely to meet the requirements. It is expected that this plant, especially designed for the upkeep of the Virginian locomotives will be an important factor in holding maintenance costs to a minimum.

Arbor for turning hollow crank pins

IN the drawing is shown a device developed by one of the employees of, and used in, the Lehigh Valley system shops, Sayre, Pa., which saves considerable time in turning crank pins because it eliminates several operations. The former method of doing this work required countersinking the crank pin hole and two operations on the lathe centers.

The arbor shown passes through the hollow crank pin and is held in the lathe centers. Two expanding rings are forced out from the arbor against the inside of the crank pin which holds it true on the arbor. In addition hardened set screws located in the faces of the expanding rings bear against the counter bore of the crank pins.

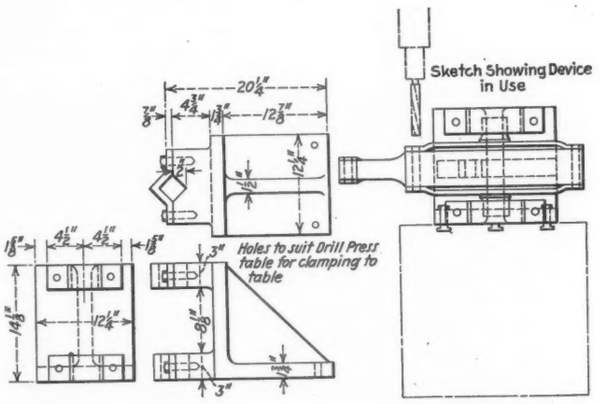


This device eliminates several operations in turning hollow crank pins

A threaded lathe dog screws on the head stock end of the arbor and tightens the expanding rings during the operation.

Drilling bolt holes in valve gear links

SHOWN in the drawing is a jig which was developed by one of the employees of the Lehigh Valley shops at Sayre, Pa. It consists of an angle plate one side of which is bolted to the drill press table. The other side



Device for drilling and reaming bolt holes in Walschaert links and link trunnions

or face contains two vee-shaped grooves over which two vee clamps are held by bolts. The link trunnions are clamped in these grooves and are held in absolute alinement with each other. While held in this manner, the bolt holes are drilled and reamed and because of the positive alinement of the jig the holes are drilled true so that no binding is caused when the trunnion and link are placed on the locomotive.

SHAPERS.—The more important and essential points in the construction of the new "American" auto-oiled heavy service shapers are described in an attractive 20-page catalogue issued by the American Tool Works Company, Cincinnati, Ohio. The automatic oiling features are shown in diagrammatic form.

The Reader's Page

Have You a Question? Ask it
Have You an Opinion? Express it

Schedule car repairs between rebuilding periods

CHICAGO, ILL.

TO THE EDITOR:

With regard to the editorial on draft gears published in the November Railway Mechanical Engineer, I believe that to maintain draft gears in efficient operating condition, eventually a periodic maintenance program for such gears will be established. The editorial in a way develops specifically a general thought that has been running through my mind for some time; the latter, however, goes very much further than a specific attachment to a freight car. I am thoroughly convinced that good and economical freight car maintenance will never be reached until the work is programmed on lines similar to those followed in maintaining locomotives. Instead of the continuous running maintenance, which is common practice between complete rebuilding periods, intermediate dates should be set up between the rebuilding dates for such repairs as will carry the car through the period with a minimum of running repair work.

Insofar as the draft gears themselves are concerned, the question of the character of test to be made at the periodical repair time is one not easy to determine unless the operation of draft gear maintenance be centralized. I have, of course, in mind the fact that a static test is of no particular value and a shock compression test must be adopted. There is another thought, of course, in this connection and that is that the periodic removal of the gear would give an opportunity to examine thoroughly the yoke and draft attachments and probably eliminate failures now occurring on these details.

T. W. DEMAREST,
General Superintendent of Motive Power, Western Region, Penna.

Shock absorption qualities of arch bar trucks

NEW HAVEN, CONN.

TO THE EDITOR:

Referring to C. F. Crosson's question in the October, 1927, issue of the *Railway Mechanical Engineer*, in regard to shock absorption of arch-bar trucks. An arch-bar truck will not absorb as much shock as a cast steel truck side. The resilience in a cast-steel truck side is far greater than that offered by an arch-bar truck. An arch-bar truck offers a great deal more deflection and sets easily, even under light loads. This is caused by the fact that an arch-bar truck is not made integral and the sets are local instead of uniform. A cast steel truck side has the greater amount of elastic strength, less deflection, a great deal less set for a given specified load, and a higher maximum breaking load. The average cast steel truck side has an elastic limit of approximately 165,000 lb. and will stand a load of approximately 250 tons.

A test has recently been made by one of the largest cast steel truck side manufacturers in the country. For a load of 95,000 lb. the deflection was .039 in. and for 180,000 lb., was .0881 in. The permanent set was .0105 in. These truck sides were for 50-ton capacity cars and were of relatively light weight. These same tests also showed that for a load of 300,000 lb. the deflection was .42 and the set was .29 in. The actual breaking loads averaged over 500,000 lb. It can be readily seen that cast steel truck sides do absorb the shock to a great extent, thus relieving the body bolster and the longitudinal sills of a great deal of shock. This absorption of shock covered over a period of years does save and prolong the life of the car to a great extent. This can be seen by the routine inspection of cars equipped with cast steel truck sides.

The American Railway Assocation recently submitted to its members by letter ballot, a proposed change in the A.R.A. standard dimensions for arch-bar trucks. This proposal met with approval, thus showing that the majority of the members of the association were aware of the fact that arch-bar trucks are not strong enough to absorb the ordinary shocks that they are subjected to.

At the June, 1927, convention at Montreal, T. W. Demarest, chairman of the Arbitration Committee of the A.R.A., stated that the arch-bar trucks are only a reasonable structure as long as everything is tight. This committee also submitted a recommendation that all cars built new after July 1, 1928, should have integral cast steel side frames. This recommendation was made to improve safety and economy.

JAMES MCDONNELL.

A Question on Rule 17

MINDEN, LA.

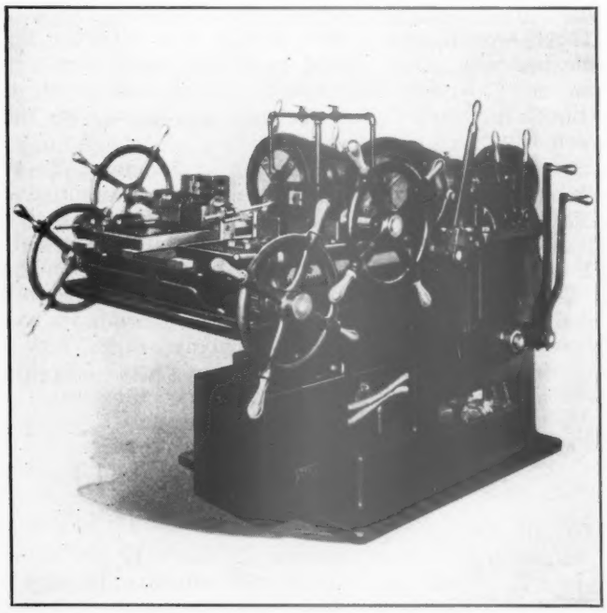
TO THE EDITOR:

Referring to Interpretation 25, Rule 17 of the revised A. R. A. interchange rules effective January 1, 1928, what kind of a coupler and yoke would be proper repairs for a car built in 1917 or 1918, which was originally equipped with 6-in. by 8-in. shank couplers, the heads of which comply with Type D specifications, but have 9½-in. butts, which are secured to the yokes by rivets? Would a 5-in. by 7-in. Type D coupler not weaken the car? Would it be permissible to apply A. R. A. type 6-in. by 8-in. couplers together with a cast steel cross key yoke and bill the owner with the betterment? What would be proper credits in either event?

J. B. SEARLES.

A double head bolt threading machine

TO meet the demands for faster bolt threading production, the Williams Tool Corporation, Erie, Pa., has started quantity production on a double-geared head bolt threading machine which has eight spindle speeds for each head. While having all of the improvements of the Williams Rapiduction, single-head bolt threading machine, the double-head threader gives a wider range of threading production, cutting ⅜-in., to 1½-in. threads with the 1½-in. size machine, and ½-in. to 2-in. with the 2-in. size machine.



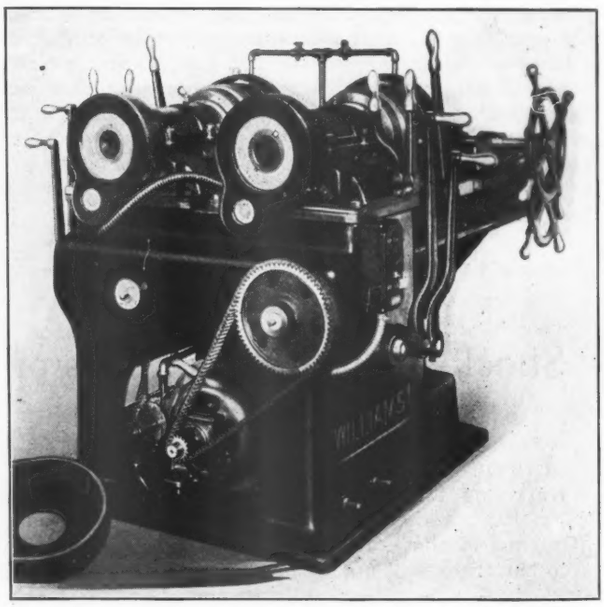
A double-head bolt threading machine with eight spindle speeds for each head

The operator has complete control from either side of the machine. For each of the die heads, the operator can select any one of eight spindle speeds. This gives the machine's maximum production on each size of bolt being threaded and also, the right speed for that size bolt can be quickly selected.

Modern machine tool design has been followed in mounting the electric motor in the base of the machine out of the way of the chips and dirt. The motor is provided with an adjustable base, enabling the operator to keep the driving chain tight at all times by a simple quick adjustment.

All the driving gears are of hardened steel, running in a constant bath of oil. In addition, the die head is furnished with ample lubrication by a chain-driven pump mounted in the base of the machine alongside of the motor. The return oil from the die head is run through a strainer to the pump and used over again. To insure full lubrication, the operator keeps the oil in the gear cases at the proper level.

The automatic die heads give the operator all the simplicity of one compact unit. Automatic compression springs open and close the dies. The heads are adjusted to the size bolt to be cut by pulling the control



The motor, which is mounted in the base, can be quickly adjusted to maintain a tight chain drive

lever forward. They are released automatically by trip rods adjusted in the carriage.

Besides, the automatic trip lever gives the operator instant control of the machine from either side. A

light push automatically disengages the die head without necessitating shutting down the machine. The trip rods on the carriage disengage the die head automatically after each threading job, as the travel of the carriage brings the trip rods in contact with the trip lever.

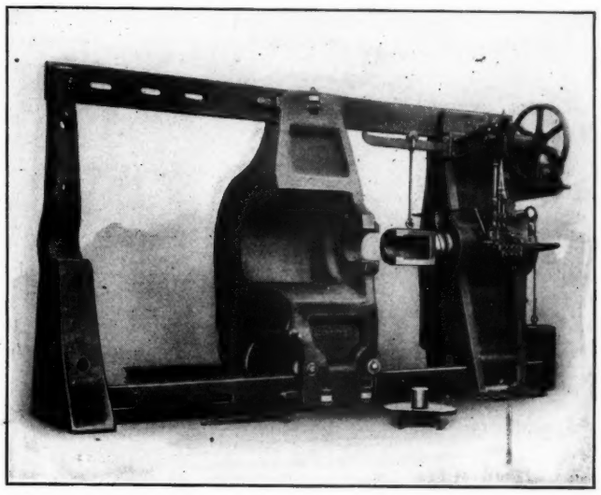
By loosening the locking screw, the dies for either head can be removed and changed in a few seconds, without removing the large die holders. One die can be replaced without removing any other die from either head.

Wheel press for three-cylinder locomotives

THE increasing use of three-cylinder locomotives on American railroads is constantly calling for more attention on the part of mechanical departments to the proper handling of the maintenance and repair of these locomotives. Recognizing the problem, the Chambersburg Engineering Company, Chambersburg, Pa., has developed a special resistance beam for its wheel presses which is arranged to assemble and disassemble the crank axles quickly and conveniently.

Counterweighted crank axles are readily accommodated and all forcing operations may be done on crank pins of wheel centers. Since frequent movements of the resistance beam are necessary in handling crank axles, means are provided through a gear train for the rapid functioning of the beam with the least possible labor. This three-cylinder crank beam is adaptable to all Chambersburg 600-ton and 800-ton presses.

All other specifications include the standing features of Chambersburg presses, among which is the rapid movement of the ram to the work by hydro-pneumatic pressure, the pressure stroke being completed by application of the three-throw pumping unit. The conveniently placed crane handles all the fixture devices between the ram and movable beam. The stress members of the press are of steel throughout and all other details are of sufficient strength and ample proportion.

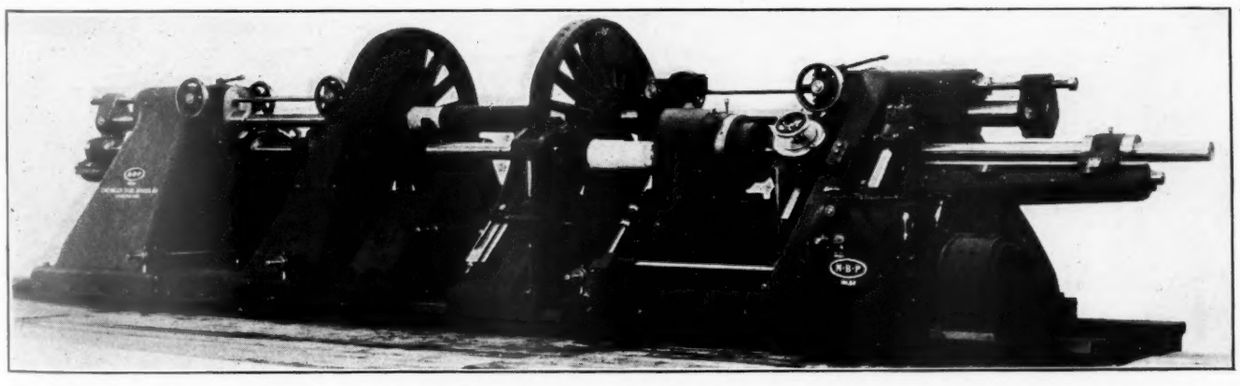


A standard Chambersburg wheel press arranged for three-cylinder locomotive repair work

Refinements in Niles 90-in. quartering machine

MANY features adding to the rigidity and the rapidity and convenience of operation have recently been embodied in the 90-in. quartering machine built by the Niles Tool Works Company, a division of the Niles-Bement-Pond Company, Hamilton, Ohio. In the original machine, the ways on the bed were of the inverted vee type, but these have now been supplanted by a bed having flat tracks affording much more effective wearing and clamping surface for the heads.

The revolving box tool crank pin head now has a bearing 10¾-in. wide as against 6-in. in the former design. In addition to the turning tools provided with the crank pin head, burnishing rollers are now also regularly furnished, the rollers having a shank fitting the toolholders. The change over from turning to burnishing can be very quickly made.



Rigidity, rapidity and convenience of operation are the objectives arrived at in the Niles redesigned 90-in. quartering machine

For rotating wheels in the central vee supports to bring them into position for quartering or pin turning, screw links with large hand wheels and bosses, tapped

left and right hand, are now furnished in place of the original turnbuckle and hooks. Each extremity is fitted with a clamp, made from steel castings, for fastening to the wheels and bed respectively.

The outer screw for elevating and lowering the quartering saddle is moved further out towards the end of the bracket upon which the box tool head slides. A bearing more than double the former width is provided to support this bracket. This eliminates any cramping action in raising or lowering the quartering saddle.

The shoes holding heads to the bed are made in two sections instead of in one piece as before, insuring more even clamping.

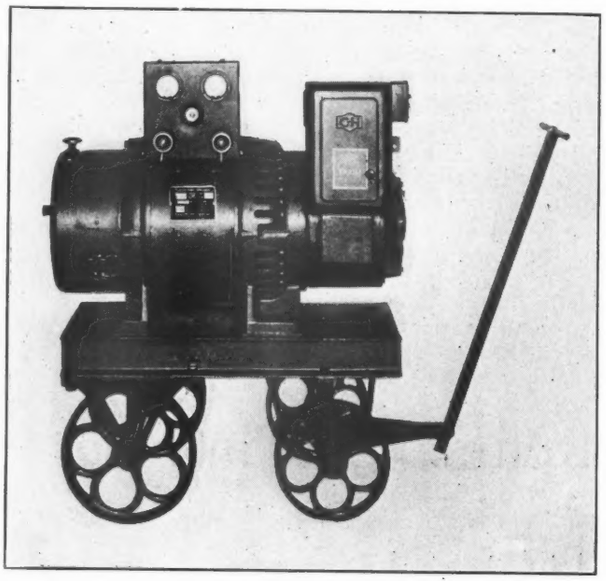
An improvement in the electrical control has been effected by a double set of push-buttons on each head, one being located out near the wheel set, the other alongside the operating hand wheels and levers for speed and feed control. Limit switches which automatically prevent over-travel of boring bears in either direction are now also regular features. In other respects the capacity and design of the machine remains unchanged.

Motor driven welder with flexible arc

THIS recent addition to the Fuzon line of arc welders, manufactured by the Fusion Welding Corporation, One Hundred Third street and Torrence avenue, Chicago, is a direct current machine operated by a three phase a. c. motor, from either a 220 or a 440-volt supply. The welding generator and the motor are both mounted on the same shaft, making a two-bearing unit.

The feature of this welding generator is its unique arc. The arc is probably best described as "flexible" because it not only possesses unusual stability but responds instantaneously to changes in arc length. For example, it is possible instantly to increase or decrease the arc length by a half inch without extinguishing it. This flexibility is made possible because all of the auxiliary apparatus usually incorporated in an arc welding unit has been eliminated. The Fuson No. 300 welder has no external stabilizer, no field rheostat and no separate exciter. These auxiliaries, especially the external stabilizer, introduce electrical inertia in the circuit so that the operator is really not connected to his source of current. When the auxiliaries are eliminated, the sluggishness due to the inertia disappears with them and the arc responds instantly to all fluctuations.

The elimination of the auxiliaries from the welding machine reduces the weight and at the same time permits rugged construction. The fact that there is but one control to govern the welding current and that this control is accomplished not by rheostats, but by a simple brush shifting device, gives the welder a very wide range of current. The current can be varied from 50 amperes to 300 amperes and over this range the arc is equally flexible and stable. This is due to the fact that shifting the brushes not only controls the current going to the operator but, at the same time and by the same control, alters the volt-ampere characteristic of the machine in such a manner that the most suitable



The Fuzon No. 300 motor driven arc welder which has no external stabilizer

characteristic is supplied at each current to which the machine is set. This permits welding metals from the thinnest to the thickest with equal facility by merely setting the current at the desired amperage.

A Yale tractor equipped with four-wheel brakes

THE Model K24C four-wheel drive tractor which has been designed by the Yale & Towne Manufacturing Company, Stamford, Conn., is capable of an ultimate drawbar pull in excess of 4,000 lb., depending upon road surface conditions, and will operate at a continuous drawbar pull of 1,000 lb. without danger of overheating. By driving all four wheels of the machine, it is possible to get the maximum of traction with the given overall weight of the machine. This feature is particularly advantageous when the tractor is used outdoors, and between buildings where there is often ice and snow during the winter months. It has the same advantage when operating in plants with floors covered with oil.

Of equal importance are the driving characteristics. The tractor is equipped with four-wheel brakes. Not only has the machine the power to pull on slippery surfaces, but it also has the power to stop. The brakes operate through the differentials so that they properly equalize regardless of the conditions of the lining. The spring which automatically applies the brakes when the operator raises his foot pedal, is directly connected to the brake shoes so that any disarrangement of the linkages between the foot pedal and the brake lever would in no way hazard the driver of the machine. Should this linkage fail, the brakes would immediately apply and warn the driver that something was wrong.

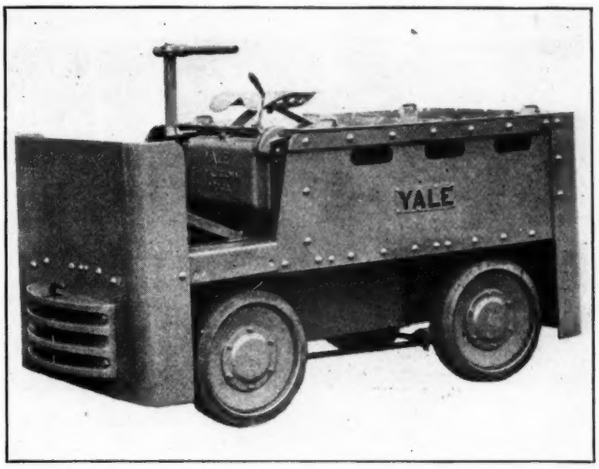
The brake foot pedal has been made sufficiently large

so that it is possible to rest both feet comfortably on the pedal which lies flush with the wooden flooring of the tractor. By a suitable arrangement of toggle joints, the pressure acquired to start the pedal in the release or downward direction, is greater than that which is required to hold the pedal down once it has been depressed. In other words, it will require no uncomfortable effort on the part of the driver to hold the pedal in the released position. To apply the brakes, the foot pedal is allowed to rise; this automatically applies the brakes and opens the cut-out switch in the controller. Should the operator at any time leave his machine or fall from it, the brakes would automatically be applied and the current cut off.

The steering is accomplished through a lever handle so arranged that the handle may be folded up out of the way if the driver wishes to leave his seat. The construction of the folding linkage is rugged so that no wear will develop in the folding mechanism, through continued use. The steering knuckles on all four driving wheels are each equipped with a ball thrust bearing, which greatly lightens the burden of steering. This is an especially important item, as it permits the driver to whip his machine quickly when in tight places, thereby gaining every inch of the turning radius of which this machine is capable.

Two standarized driving units are applied in the truck, connected in parallel at the controller. The employment of standard units allows a maximum of interchangeability in the hands of the purchaser, as it would be possible for him to maintain but one set of repair parts for all of the Yale trucks and tractor models. It would be possible to interchange the entire drive units of this tractor with any of the Yale K line of industrial trucks. This machine is regularly furnished with a 48-volt motor and a 23 to 1 gear ratio.

The frame construction of the tractor is unique in that the pressed steel side members or main supporting members are strong integral parts with the axle yokes. This gives the frame a depth of 18-in., producing a



The Yale K24C tractor which will operate at a continuous draw-bar pull of 1,000 lbs.

member thoroughly capable of standing jolts and jars in addition to the usual bending stresses to which it is subjected. The bumpers are heavy, being made of ½-in. plates. A triple bumper casting, front and rear, gives a range of coupling height that will meet practically every requirement.

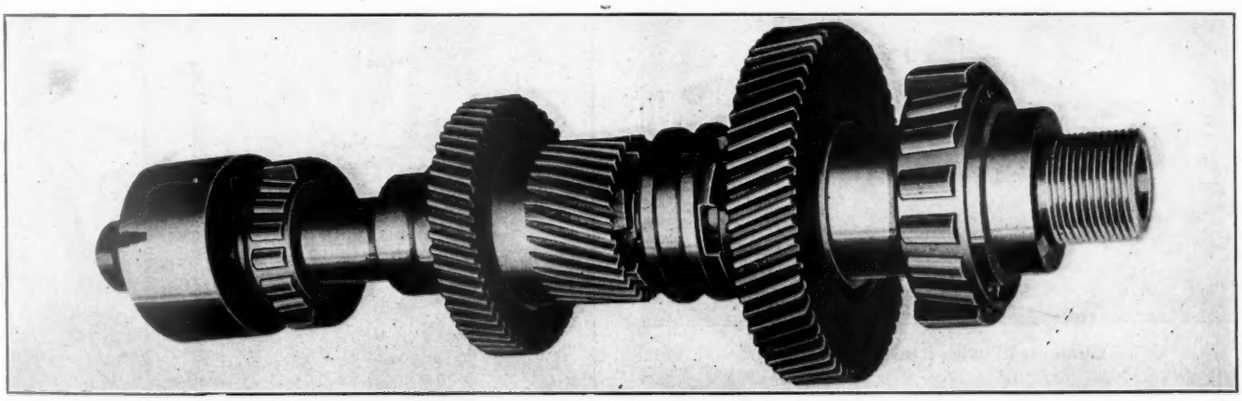
Lathe spindles equipped with roller bearings

TO meet the increasing demand for anti-friction bearings, the helical geared head lathes from 14-in. to 30-in. sizes, incusive, manufactured by the Monarch Machine Tool Company, Sidney, Ohio, are now offered with spindles mounted in precision type Timken tapered roller bearings. These bearings, which are made to tolerance limits of .0002 in., insure accurate spindle alinement. It is reasonable to expect this accuracy to be retained indefinitely owing to the ample reserve capacity in the bearings selected for each size of lathe.

All end thrust of the spindle is taken against the front bearing. In mounting the bearings, an initial thrust load is imposed, thereby removing all radial as well as end movement of the spindle. Adjustment is provided for the bearings, but only very infrequent adjustment should be necessary.

Because, with a spindle mounted in plain bearings, a film of oil between the bearings and spindle is always necessary, while with the anti-friction bearing there is a metal-to-metal contact. It is possible to take heavier cuts without chatter than is possible with plain bearings.

Clean filtered oil is supplied to both spindle bearings. Bearings with ample radial and thrust capacity, are selected for each size of lathe.



A spindle of a Monarch helical geared lathe equipped Tim ken tapered roller bearings

A 6-ft. extension added to plate rolls

A VERY unusual job was successfully accomplished when a set of 34-ft. plate rolls at the General American Tank Car Corporation was lengthened to 40 ft. The original machine, a Ryerson-Kling bending roll, manufactured by Joseph T. Ryerson & Son, Inc., Chicago, had a capacity of 34 ft. 2 in. by ¾ in., with an upper roll 29 in. in diameter and two 20-in. lower rolls. It had been in service since its installation in 1919.

In making the addition it was necessary to dismount the rollers, extend the base, and move out the rear housing. The 6-ft. extensions, made of Mayari iron, were slipped over the journals and welded along the circumference of the joints. Additional center support was furnished and placed at the joints of the lower rollers.

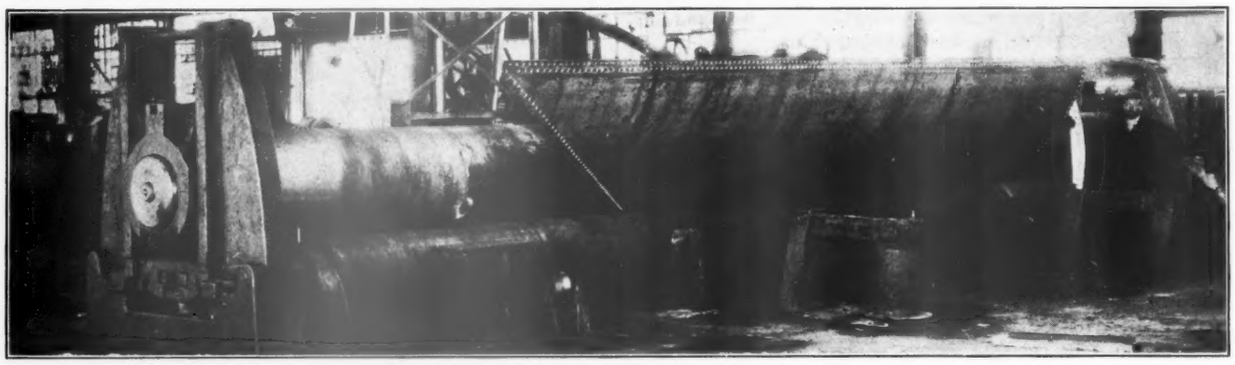


Plate bending rolls enlarged from 36 ft. to 40 ft.

A subsequent order calling for the rolling of 200 ½-in. by 8-ft. by 38-ft. plates to a 34-in. radius paid for the entire extension.

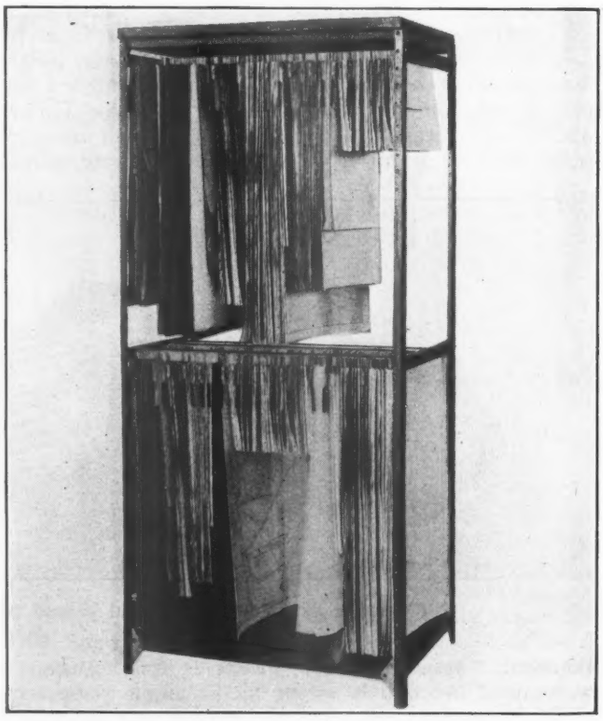
Filing system for drawings, maps and plans

MANY desirable features are incorporated in the filing system for drawings, maps and plans, announced by The Globe-Wernicke Company, Cincinnati, Ohio. The nucleus of the system is a clip composed of a strip of celluloid enclosed in India rubber adhesive cloth. One end of the clip is attached by adhesion to the drawing. The other end contains a hole and slit that permits of suspending the sheet by snapping the clip over horizontal rods. Two or more clips are used per sheet and the sheets are strung on an assembly of polished rods that are mounted in cabinets or in open racks.

Guide card with two "cello-clips"

Mounted on the assembly of polished rods is a set of six riders made of ply-wood. These riders enable the contents of the rack to be shifted laterally to gain access for the removal of a drawing. The clips also serve as "handles" to the drawing, and it is not necessary for the hands to come in contact with the sheets when removing or replacing a drawing.

Guide cards are distributed along the rod assembly



The Globe-Wernicke open rack for filing drawings, tracings, etc.

to produce a visible index. Numerical guides with green and yellow angle tabs are used to form a numerical index and the location of specific drawings or subdivisions of the file are marked by guide cards with orange angle tabs. All sheets are visible and equally accessible, regardless of the size of the sheet and any sheet may be referred to without removal from the file.

The filing and finding time is held to the minimum because only the desired sheet is handled. The life of a drawing is lengthened and its usefulness increased by this method of filing, because there is no contact between adjacent sheets, no friction when pulling out or "tucking" a sheet. It is unnecessary to thumb the corners of the sheets when searching for a specific drawing. The clip suspension is suitable for paper and Ozalid and Van Dyke prints.

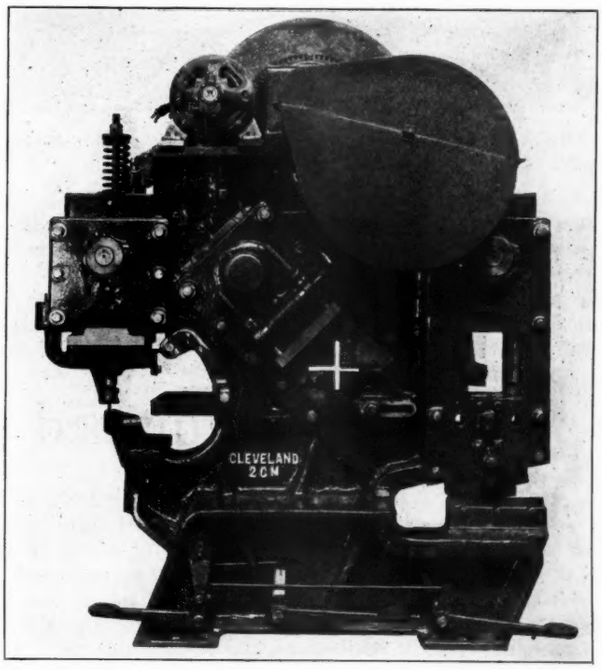
When the storage is in a vault, the enclosing cabinet may be omitted and the rod assemblies mounted in racks. These racks, one of which is illustrated, may be made to suit the dimensions of the vault and a compact arrangement of high capacity produced without cramping and with equal visibility and accessibility for all drawings.

Cleveland combination punch and shear

A COMBINATION punch and shear at which three men can work at the same time with each operation separately controlled has been placed on the market by the Cleveland Punch & Shear Works Company, Cleveland, Ohio. The frame is a solid steel casting in which are located the bearings for the main shaft. The die block is designed for punching minimum and maximum web and flange sections without changing the block. The distance from the face of the block to the center of the die is variable in the single and triple punching attachments and may be changed without moving the punch blocks. The machine is furnished with dual stripper lugs and a floating punch attachment. The interchangeable triple gag attachment on the machine permits punching three sizes of holes at various gages at one set-up.

The punches may be placed either parallel or at right angles to the main shaft on the triple gag. The extended lower splitting shear blade furnishes a support for the material when starting a cut. The internal notching attachment for a rectangular and 45 deg. notches combines safety and saves overall space. The punching splitting and angle cutting units are individually operated by four-jaw clutches which run in oil. Automatic lubrication is supplied to the fly wheel.

The die space is suitable for additional special attachments for plate bevelling, cluster punching, special notching and coping and twisting bars. The machine will punch the flanges and webs of 4-in. to 15-in. I-beams, 4-in. to 8-in. columns and 1 1/16-in. holes in plates 5/8-in. thick. It will notch 6-in. I-beams, 8-in. channels and 2-in. by 2-in. by 1/4-in. angles. It will shear 4-in. by 4-in. by 1/2-in. tees and angles, 6-in. I-beams and 9-in. channels. The machine will cut 45 deg. notches in 2-in. by 2-in. by 1/4-in. angles and 8-in. channels. The machine can also be furnished in a smaller or larger size.



The Cleveland No. 2 combination punch and shear

McCrosky redesigned Neva-Stop face plate

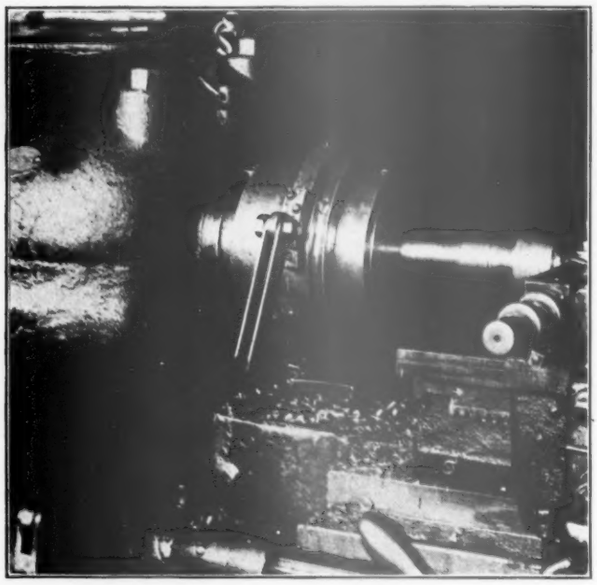
THE purpose of the redesigned Neva-Stop face plate, manufactured by the McCrosky Tool Corporation, Meadville, Pa., is the same as that of the earlier model—to enable an engine lathe operator to change work done on centers without stopping his machine. In place of only two driving jaws, the face plate has three as is shown in the unassembled view. This change gives a surer and better distributed application of the driving power than was possible with the earlier two-jaw design. The body is now made from a solid steel disk, and the front plate and guide plate have been materially strengthened. All wearing parts are hardened. The jaws are made from special drop-forged alloy steel and are hardend for durability.

This face plate, like the earlier model, is designed to handle work done on centers and is screwed on to the lathe spindle. The work is gripped and driven by serrated jaws which are brought into contact with the work by springs, but the driving pressure is secured by the camming action of the jaws.

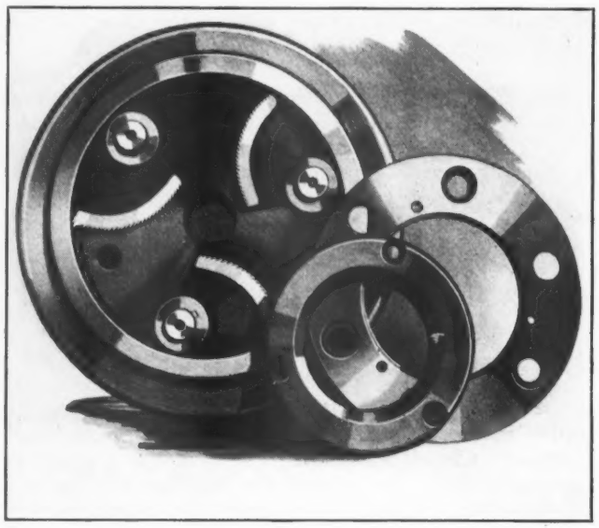
To release the work, the operator applies a slight resistance on the outside collar of the revolving plate. This automatically opens the cam jaws and locks them open. A new piece of work is placed on the centers while the spindle is turning. The operator touches a trip located in the collar, which instantly releases the

jaws which begin to drive the work without stopping.

The face plate can also be furnished with a plain, wide collar in place of the collar with a trip. This type is operated by a simple friction brake that can be made in the shop of the user from a print furnished by the manufacturer. To apply the brake, the operator steps on a treadle which provides the necessary friction on the collar to open the jaws and hold them open. When a new piece has been put on the centers, releasing the brake allows the jaws to engage the work. This arrangement increases the speed with which work can be changed without stopping the lathe and is particularly recommended where one operator is in charge of more than one machine. The jaws of the face plate are designed primarily for driving work that is concentric and symmetrical, but they will adjust themselves to drive work that is slightly out of round.



The Neva-Stop face plate provided with a foot brake



The jaws open ready to receive the work

The face plate is 8⅜ in. in diameter overall. The body portion is 6⅝ in. in diameter. It is left blank so that it can be bored out and threaded to fit the spindle of the particular lathe on which it is used. The device is furnished with two sets of jaws, handling work from ⅜ in. to 2½ in. in diameter. Jaws to handle larger diameters can be furnished on request.

Spray gun equipped with an adjustable head

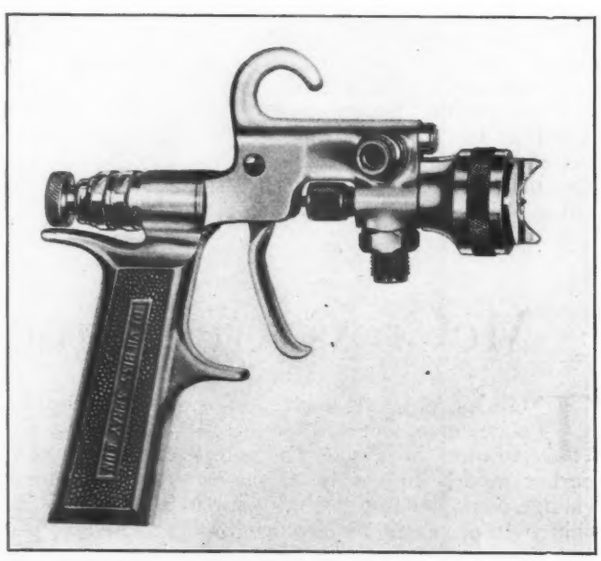
A REDESIGNED spray gun, featuring particularly a spray head with a graduated adjustment controlling both the character and width of the fan spray, and a type of construction insuring positive self-centering of the nozzle parts at all times, has recently been placed on the market by the De Vilbiss Company, Toledo, Ohio.

The graduated adjustment makes possible a quick return to a previous setting for producing any desired spray. The air can also be cut off, producing a round spray. This adjustable spray head eliminates split sprays, and "overspray," and insures proper balance between the amount of material used, nature of work and speed of operation.

Another feature is the positive self-centering of the nozzle parts, based on an absolutely correct mechanical principle, making it impossible for these parts to get out of alinement.

The detachable spray head construction is retained, simplifying operation, cleaning and care. Also additional interchangeable spray heads can be carried with nozzles in a variety of sizes. In addition, a spray head with the adjustable feature, interchangeable with the adjustable type, producing either a fan or round spray, can be furnished.

Type AV spray gun construction is such that with low air pressure ranging from 40 to 60 lb. and a minimum air consumption, the material is finely, softly and evenly atomized, and a smooth and uniform coating applied.



The De Vilbiss Type AV spray gun equipped with an adjustable spray head

News of the Month

I. C. C. asked to require automatic hose connectors

A DELEGATION OF OFFICERS of the brotherhoods of train service employees recently held an informal conference with Chairman Esch and Commissioner Taylor of the Interstate Commerce Commission at which they urged the commission to consider the advisability of requiring the railroads to equip their cars with automatic brake-hose connectors. Such a plan has been proposed in resolutions adopted at some of the brotherhood conventions. The proposal will be laid before the commission for consideration. An impression seems to have gone abroad that this was to be a hearing at which representatives of the railways and of the manufacturers were to be present and some people went to Washington to attend such a hearing, but it was explained that it was merely a preliminary discussion of the subject arranged at the request of the brotherhoods for the purpose of placing the subject before the commission for its consideration.

Safety education for February

THE PROGRAM of the Committee on Education, of the Safety Section, A. R. A., for the month of February, emphasizes that part of the accident record which includes cases due to unsafe practices in shops, etc. A large colored bulletin has been issued illustrating some of the things which the careful man will avoid.

Noting the fact that 20 per cent of all accidents under this head occur in the use of hand tools, the circular notes that many bruises and broken bones result from using ill-fitting wrenches. Make-shift scaffolds appear frequently in the records; a workman needs a safe scaffold for a job of five minutes, the same as he does for one of two hours. Tools falling from places where they have been left carelessly as on the running board of a locomotive, cause shop accidents. It is suggested that members of safety committees, specialize on this particular item for 30 days. The goggle problem is yet unsolved in many shops, and attention is called to the successful results in shops where a man neglecting to wear goggles, when necessary, incurs liability of being dismissed.

Meetings and Conventions

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs.

AIR-BRAKE ASSOCIATION.—T. L. Burton, 165 Broadway, New York. Next meeting May 1-4, Detroit, Mich.

AMERICAN RAILWAY ASSOCIATION DIVISION V.—MECHANICAL.—V. R. Hawthorne, 431 South Dearborn St., Chicago. Next meeting June 20 to 27, 1928, inclusive, Atlantic City, N. J.

DIVISION V.—EQUIPMENT PAINTING SECTIONS.—V. R. Hawthorne, Chicago.

DIVISION VI.—PURCHASES AND STORES.—W. J. Farrell, 30 Vesey St., New York. Next meeting June 20-22.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—G. G. Macina, 11402 Calumet Ave., Chicago. Annual convention Hotel Sherman, Chicago, August 29-31, 1928.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Railroad Division, Marion B. Richardson, associate editor, *Railway Mechanical Engineer*, 30 Church St., New York.

AMERICAN SOCIETY FOR STEEL TREATING.—W. H. Eiseman, 4600 Prospect Ave., Cleveland, Ohio. First semi-annual meeting February 16 and 17 Mount Royal Hotel, Montreal, Canada.

AMERICAN SOCIETY FOR TESTING MATERIALS.—C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Annual meeting June 25-29, Chalfonte-Haddon hotel, Atlantic City, N. J.

AMERICAN WELDING SOCIETY.—Miss M. M. Kelly, 29 West Thirty-ninth St., New York.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Joseph A. Andrucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago, Ill.

BIRMINGHAM CAR FOREMEN AND CAR INSPECTORS' ASSOCIATION.—Maynard Rodgers, secretary, care Y. M. C. A., Birmingham, Ala. Meeting second Monday in each month at Birmingham Y. M. C. A. building.

CANADIAN RAILWAY CLUB.—C. R. Crook, 129 Charon St., Montreal, Que. Regular meetings, second Tuesday in each month, except June, July and August, at Windsor Hotel, Montreal, Que. Next meeting February 14. Paper on locomotive boiler development will be presented by C. A. Brandt, chief engineer, the Superheater Company, New York.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Aaron Kline, 626 N. Pine Ave., Chicago, Ill. Regular meeting second Monday in each month, except June, July and August. Great Northern Hotel, Chicago. Next meeting February 13. Continued discussion new A. R. A. Rules.

CAR FOREMEN'S ASSOCIATION OF ST. LOUIS.—A. J. Walsh, 5874 Plymouth Apt. 18, St. Louis, Mo. Regular meeting first Tuesday in each month, except June, July and August, at Broadview Hotel, East St. Louis, Ill.

CAR FOREMEN'S CLUB OF LOS ANGELES.—J. W. Krause, 514 East Eighth St., Los Angeles, Cal. Meeting second Friday of each month in the Pacific Electric Club building, Los Angeles, Cal.

CENTRAL RAILWAY CLUB.—H. D. Vought, 26 Cortlandt St., New York. Regular meetings second Thursday each month, except June, July and August, at Hotel Statler, Buffalo. Next meeting February 9. Paper on yard costs will be read by H. P. Fertig, chief of yard and terminal operations, Chicago, Rock Island & Pacific, Chicago.

CHIEF INTERCHANGE CAR INSPECTORS' AND CAR FOREMEN'S ASSOCIATION.—(See Railway Car Department Officers' Association.)

CINCINNATI RAILWAY CLUB.—D. R. Boyd, 330 Beekman St., Cincinnati, Regular meeting second Tuesday, February, May, September and November.

CLEVELAND RAILWAY CLUB.—F. L. Frericks, 14416 Adler Ave., Cleveland, Ohio. Meetings first Monday each month, except July, August and September, at Hotel Hollenden, East Sixth and Superior Ave., Cleveland. Next meeting February 6. Discussion changes in 1928 A. R. A. rules.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—W. J. Mayer, Michigan Central, 2347 Clark Ave., Detroit, Mich. Next meeting Hotel Sherman, Chicago, August 21-23, 1928.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—L. G. Plant, Railway Exchange, 80 E. Jackson Boulevard, Chicago. Next meeting Chicago, May 7-11, 1928.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall 1061 W. Wabash Ave., Winona, Minn. Annual convention Hotel Sherman, Chicago, September 4-7, 1928.

LOUISIANA CAR DEPARTMENT ASSOCIATION.—L. Brownlee, 3212 Delachaise street, New Orleans, La. Meetings third Thursday in each month.

MASTER BOILERMAKERS' ASSOCIATION.—Harry D. Vought, 26 Cortlandt St., New York. Annual meeting Cleveland, Ohio, May 22-25.

NEW ENGLAND RAILROAD CLUB.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Regular meeting second Tuesday in each month, excepting June, July, August and September, Copley-Plaza Hotel, Boston. Next meeting February 14.—Paper on the Diesel engine in railroad traction will be presented by D. L. Bacon, superintendent automotive equipment, N. Y. N. H. & H. Illustrated with lantern slides.

NEW YORK RAILROAD CLUB.—H. D. Vought, 26 Cortlandt St., New York. Meetings third Friday in each month, except June, July and August, at 29 West Thirty-ninth St., New York.

PACIFIC RAILWAY CLUB.—W. S. Wollner, 64 Pine St., San Francisco, Cal. Regular meetings, second Thursday of each month in San Francisco and Oakland, Cal., alternately.

RAILWAY CAR DEPARTMENT OFFICERS' ASSOCIATION.—A. S. Sternberg, Belt railway, Clearing Station, Chicago.

RAILWAY CLUB OF GREENVILLE.—Paul A. Minnis, Bessemer & Lake Erie, Greenville, Pa. Meeting last Friday of each month, except June, July and August.

RAILWAY CLUB OF PITTSBURGH.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Regular meeting fourth Thursday in month, except June, July and August. Fort Pitt Hotel, Pittsburgh, Pa.

ST. LOUIS RAILWAY CLUB.—B. W. Frauenthal, M. P. O. Drawer 24, St. Louis, Mo. Regular meetings, second Friday in each month, except June, July and August.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—A. T. Miller, P. O. Box 1205, Atlanta, Ga. Regular meetings third Thursday in January, March, May, July, September and November. Annual meeting third Thursday in November. Ansley Hotel, Atlanta, Ga.

SOUTHWEST MASTER CAR BUILDERS' AND SUPERVISORS' ASSOCIATION.—B. B. Parker, St. Louis-Southwestern, Tyler, Tex. Annual meeting August 4, 5 and 6 at Galveston, Tex.

TEXAS CAR FOREMEN'S ASSOCIATION.—A. I. Parish, 106 West Front St., Fort Worth, Tex. Regular meetings first Tuesday in each month. Terminal Hotel bldg., Fort Worth, Tex.

TRAVELING ENGINEERS' ASSOCIATION.—W. O. Thompson, 1177 East Ninety-eighth St., Cleveland, Ohio. Annual meeting Hotel Sherman, Chicago, October, 1928.

WESTERN RAILWAY CLUB.—W. J. Dickinson, 189 West Madison St., Chicago. Regular meetings, third Monday in each month, except June, July and August. Next meeting Feb. 20.—Hotel Sherman, Chicago. "Why a supplyman?" will be the topic discussed.

Supply Trade Notes

WILLIAM BYRON RUFE, secretary of Jenkins Bros., New York, died on November 27.

WILLIAM SCHWANHAUSSER, chief engineer of the Worthington Pump & Machinery Corp., died on January 15 at the Peck Memorial hospital, Brooklyn, N. Y., after six months' illness, at the age of 73.

H. W. OSTROM, who resigned as chief chemist of the Chicago, Milwaukee & St. Paul with headquarters at Milwaukee, Wis., to accept a position with the Aluminum Company of America, as reported in the January *Railway Mechanical Engineer*, was born August 29, 1896. After receiving his elementary education in the Chicago public schools, he took undergraduate work at the University of Illinois, two years of graduate work at Armour Institute and one year of graduate work at the University of Wisconsin. Immediately subsequent to 1918 Mr. Ostrom worked one year for the Illinois Steel Company in the plant laboratory as chemist, then being employed for another year with Wilson & Co., Chicago, on plant research work. During the succeeding four years, he worked for the Illinois Central as chemist and for the past four years for the Chicago, Milwaukee & St. Paul as chief chemist reporting to the general superintendent of motive power and being responsible for materials testing. Mr. Ostrom's present work includes sales and development of aluminum bronze powder used for railway paints, fireworks, rubbers, inks, etc., his headquarters being in Chicago.

H. W. Ostrom

GEORGE W. MCINTYRE, formerly representative of the Niles-Bement-Pond Company has been appointed representative of Reed-Prentice Corporation, with headquarters at 75 West Street, New York City.

CHARLES H. LEINERT, president of the Leinert Valve Company, Inc., with office at 310 South Michigan avenue, Chicago, has been appointed district representative in the Chicago district, for the Birdsboro Steel Foundry & Machine Company, Birdsboro, Pa.

M. J. SCHMITT, formerly in charge of Milwaukee branch of the Kearney & Trecker Corporation, has been promoted to the new position of assistant sales manager. Mr. Schmitt will continue to look after the Milwaukee territory with the assistance of R. F. Shaw, who is being transferred from the Chicago branch to the home office at Milwaukee.

THE HARRISON STEEL CASTINGS COMPANY, Attica, Ind., has acquired all of the assets and real estate of the National Car Coupler Company, Attica. This company will operate the plant, continuing the manufacture of miscellaneous steel castings, knuckles and couplers with the same management and policies under which the former company operated.

C. N. THULIN, vice-president of the Duff Manufacturing Company, Pittsburgh, Pa., has taken over the supervision of the eastern sales district in addition to the western sales district of which he has been in charge for several years. Mr. Thulin's headquarters will be in New York and Chicago. W. G. Robb has been appointed district manager of the New York district, with headquarters at 250 Park Avenue, New York. P. G. O'Hara, former vice-president in charge of the Eastern District has resigned to join the organization of the Vacuum Oil Company at New York City.

THE BOARD OF DIRECTORS of the United States Steel Corporation after its meeting on December 27 announced that the chairman of the board is no longer an executive officer of the company. James A. Farrell continues as president of the corporation and becomes its chief executive officer, under the direction and supervision of the finance committee and the board of directors. John Pierpont Morgan becomes chairman of the board, and Myron C. Taylor becomes chairman of the finance committee. The above action was taken to fill the vacanies caused by the death of Judge Elbert H. Gary.

THE AMERICAN ROLLING MILL COMPANY has taken over and is directing the sales of the forged steel wheels manufactured by the Forged Steel Wheel Company, whose properties were recently acquired by the American Rolling Mill Company from the Standard Steel Car Company. While the sales of wheels are being conducted by the American Rolling Mill Company through its forged steel wheel division, the Standard Steel Car Company is retaining a substantial interest in the business. Harry Holiday, formerly vice-president of the Forged Steel Wheel Company, is general manager of sales with headquarters in Pittsburgh, Pa., W. B. Quail, formeriy with the Standard Steel Car Company, is manager of sales of the eastern district, with headquarters at New York; William A. Libkeman, western sales agent of the Standard Steel Car Company, is sales representative and is directing the sales at Chicago; Blake C. Howard, president of the Equipment Sales Corporation, is directing the sales at the St. Louis office.

ZENO C. WILKINSON, sales manager of the Youngstown Pressed Steel Company, Warren, Ohio, has resigned from that company to become vice-president and director of the Peter Smith Heater and Manufacturing Company, Detroit, Mich. Mr. Wilkinson has been in the steel business all of his business life, having been identified with the United States Steel Corporation at Gary, Ind., and the Bethlehem Steel Corporation before serving with the Youngstown Pressed Steel Company. In his new position he will be part owner of the company and have charge of both manufacturing and sales. Peter Smith Heater & Manufacturing Company is the new name of the Peter Smith Heater Company, which has been in business in Detroit for the past 45 years engaged in the manufacture of heating units for steam railway and electric cars. The new company will have two departments, the pressed steel division and the heater division. A new unit shop will be constructed in the spring as an addition to the present plant at Detroit. E. J. Smith is president of the new organization, and M. J. Phelan is secretary.

FOUR ENGINEERING FIRMS have combined their interests and organized the United Engineers & Constructors, Inc. These companies are the United Gas Improvement Contracting Company, Philadelphia, Pa., the Public Service Production Company, Newark, N. J., Dwight P. Robinson & Co., Inc., New York, and Day & Zimmermann Engineering & Construction Co., Philadelphia. The headquarters of the new company will be in Philadelphia, with offices in New York, Newark, Chicago, Los Angeles, Atlanta, Houston, Pittsburgh, Montreal, Buenos Aires and Rio de Janeiro. Dwight P. Robinson is president of the company. The directors are Arthur W. Thompson, president of the United Gas Improvement Company, chairman; Dwight P. Robinson; Thomas N. McCarter, president, Public Service Corporation of New Jersey; Samuel T. Bodine, chairman of board of directors, the United Gas Improvement Company; Paul Thompson, a vice-president of the United Gas Improvement Company and president of the Philadelphia Gas Works Company, and John E. Zimmermann, president of Day & Zimmermann, Inc. The new company has contracts in hand amounting to more than $100,000,000.

Personal Mention

General

ALFRED G. HOPPE, who has been appointed engineer of tests of the Chicago, Milwaukee & St. Paul, with headquarters at Milwaukee, Wis., was born in 1895 at Milwaukee. He attended the Milwaukee grammar and high schools and was graduated from the University of Wisconsin in 1917. He entered the service of the C. M. & St. P. in 1911, working in the blacksmith shop and drafting room during summer vacations. In 1919 he entered the permanent employ of the C M. & St. P., serving successively as draftsman, mechanical inspector, chief mechanical inspector of the test department, and assistant engineer of tests.

A. G. Hoppe

GEORGE THIBAUT, shop superintendent of the Erie at Meadville, Pa., has been appointed assistant mechanical superintendent, New York District, with headquarters at Jersey City, N. J.

FREDERICK H. MURRAY, who has been appointed mechanical superintendent of the New York and Eastern districts of the Erie, with headquarters at Hornell, N. Y., was born on February 24, 1875. He entered the service of the Erie in June, 1893, as a bolt cutter at Meadville, Pa., remaining in that position until October of the same year. From October, 1893, until October, 1897, he served as a machinist apprentice at the same place, and from the latter date until October, 1899, successively served as a machinist at the following places: Meadville, Pa.; Brier Hill, Ohio, and again at Meadville, Pa. For a year he served in the same capacity at the Phoenix Iron Works at Meadville. In October, 1900, he became roundhouse foreman of the Erie at Meadville, and in December, 1902, became general foreman at Salamanca, N. Y., being transferred in the same capacity to Jersey City, N. J., in January, 1904. He remained here until October, 1910, and was then appointed master mechanic at Port Jervis, N. Y., remaining there until September, 1914, when he was transferred in the same capacity to Jersey City, N. J., which position he held until July, 1918. He then became inspector of mechanical maintenance for the federal manager. He served in this capacity until September, 1919, and again became master mechanic at Jersey City, N. J., where he remained until February, 1920. From March, 1920, until October of the same year, Mr. Murray was shop superintendent at Susquehanna, Pa., and was then appointed mechanical superintendent of the Hornell region at Hornell, N. Y., which position he held until November, 1922, when he was appointed master mechanic at Salamanca, N. Y. He served there until June, 1927, and was then transferred in the same capacity to Cleveland, Ohio, which position he was holding at the time of his recent appointment.

F. H. Murray

Master Mechanics and Road Foremen

FRED H. RUSSELL has been appointed road foreman of engines of the Michigan Central, with headquarters at Detroit, Mich.

H. R. SPORE has been appointed assistant foreman of engines of the Fort Wayne division, Western Region, of the Pennsylvania.

G. C. SMITH, assistant road foreman of engines of the Michigan Central, has been appointed road foreman of engines, with headquarters at Niles, Mich.

E. J. MITCHELL has been appointed assistant road foreman of engines of the Michigan Central, with headquarters at Jackson, Mich.

H. SMITH has been appointed master mechanic of the London division of the Canadian Pacific, with headquarters at London, Ont.

C. W. STOKES has been appointed general road foreman of motive power and equipment of the Southern Pacific with headquarters at Houston, Tex.

F. WISEMAN, road foreman of engines on the Michigan Central at Jackson, Mich., has been promoted to assistant master mechanic, with headquarters at the same point.

DON NOTT has been appointed assistant master mechanic of the Galesburg division of the Chicago, Burlington & Quincy, with headquarters at Galesburg, Ill.

D. C. COSSAR, locomotive foreman on the Alberta district of the Canadian Pacific at Medicine Hat, Alta., has been promoted to division master mechanic of the Brandon division, with headquarters at Brandon, Man.

R. A. WALKER, master mechanic of the Northwestern district of the Missouri-Kansas-Texas, at Wichita Falls, Tex., has been transferred to the McAlester district, with headquarters at Muskogee, Okla., succeeding W. H. McCune.

A. J. LEWIS, master mechanic of the North Texas division of the Missouri-Kansas-Texas at Denison, Tex., has been transferred to the Parsons district as master mechanic, with headquarters at Parsons, Kan., to succeed J. J. Melley, resigned.

W. H. MCCUNE, master mechanic of the McAlester district of the Missouri-Kansas-Texas, at Muskogee, Okla., has been transferred to the North Texas district, with headquarters at Denison, Tex.

H. J. WADE has been appointed acting road foreman of engines of the Joplin division of the Missouri Pacific with headquarters at Nevada, Mo., succeeding E. F. Putnam, who is on leave of absence on account of ill health.

GRANT W. STANTON, traveling engineer of the Minneapolis, St. Paul & Sault Ste. Marie, at Minneapolis, Minn., has been appointed master mechanic of the Winnipeg division, with headquarters at Thief River Falls, Minn., succeeding Arthur L. Fillmore, deceased.

CLARENCE H. NORTON, master mechanic of the Susquehanna, Allegheny, Tioga and Bradford divisions of the Eastern district of the Erie, at Hornell, N. Y., has been appointed shop superintendent, with the same headquarters, succeeding Albert J. Davis, resigned.

ALBERT SUTHERBY, master mechanic on the Western district of the Erie, with headquarters at Youngstown, Ohio, has been transferred in the same capacity to the Mahoning division and the Kent and Akron terminals, with headquarters at Cleveland, Ohio.

B. C. NICHOLSON, general foreman on the Parsons district of the Missouri-Kansas-Texas at Oklahoma City, Okla., has been promoted to master mechanic of the Northwestern district, with headquarters at Wichita Falls, Tex., succeeding R. A. Walker.

W. E. HARMISON, master mechanic of the Delaware and Wyoming divisions of the Erie and the Wilkes-Barre & Eastern Railroad, with headquarters at Port Jervis, N. Y., has been transferred in the same capacity to Meadville, Pa., succeeding T. F. Gorman.

J. H. WINFIELD, general inspector of the Eastern district of the Erie at Hornell, N. Y., has been appointed master mechanic of the Delaware and Wyoming divisions of the Erie and the Wilkes-Barre & Eastern Railroad, with headquarters at Port Jervis, N. Y., succeeding W. E. Harmison.

S. L. LANDIS, superintendent of fuel conservation of the Missouri Pacific at St. Louis, Mo., has been appointed road foreman of engines of the Coffeyville, Conway Springs, Arkansas City and Roper districts of the Southern Kansas division, and also of the Kansas City district of the Central Kansas division, with headquarters at Osawatomie, Kan., succeeding H. J. Wade.

Shop and Engine House

T. M. TEMISON has been promoted to enginehouse foreman of the Missouri Pacific, with headquarters at DeQuincy, La.

WILLIAM HORNING has been appointed assistant foreman of engines of the Fort Wayne division, Western Region, of the Pennsylvania.

W. E. SCRIPTER has been appointed assistant foreman of engines of the Fort Wayne division, Western Region, of the Pennsylvania.

R. M. CALKINS, night enginehouse foreman of the Missouri-Kansas-Texas, at Parsons, Kan., has been promoted to general foreman, with headquarters at Oklahoma City, Okla.

HARRY CHILTON has been promoted to machine shop foreman of the Boston & Albany, with headquarters at W. Springfield, Mass., succeeding J. H. Murphy.

CHARLES M. RAYMOND has been promoted to assistant machine shop foreman of the Boston & Albany, with headquarters at W. Springfield, Mass, succeeding J. H. Murphy.

G. D. BOYER has been promoted to assistant night enginehouse foreman of the Missouri-Kansas-Texas, with headquarters at Parsons, Kan., succeeding F. J. Burke.

C. E. HORSLEY, general foreman of the Illinois Central at Mounds, Ill., has been appointed general foreman, with headquarters at East St. Louis, Ill.

D. O. WATSON, erecting shop foreman of the Wabash at Decatur, Ill., has been appointed roundhouse foreman of the St. Louis-Southwestern, with headquarters at Pine Bluff, Ark.

T. F. GORMAN, master mechanic of the Meadville division of the Erie at Meadville, Pa., has been appointed shop superintendent, with the same headquarters, succeeding George Thibaut.

GEORGE L. WEAVER, machine shop foreman of the Missouri Pacific, has been promoted to erecting shop foreman, with headquarters at DeQuincy, La.

ROBERT STALLCUP has been promoted to machine shop foreman of the Missouri Pacific, with headquarters at DeQuincy, La., succeeding G. L. Weaver.

J. J. DUGAN has been promoted to night enginehouse foreman, Harahan Yards, of the Illinois Central, with headquarters at New Orleans, La., succeeding C. G. Havers.

CHARLES G. HAVERS, night enginehouse foreman, Harahan Yards, of the Illinois Central, has been promoted to day enginehouse foreman, Government Yards, with headquarters at New Orleans, La.

F. J. BURKE, assistant night enginehouse foreman of the Missouri-Kansas-Texas, has been promoted to night enginehouse foreman, with headquarters at Parsons, Kan., succeeding R. M. Calkins.

Car Department

J. B. FERRELL, car foreman of the Missouri Pacific at Texarkana, Ark., has been transferred to Alexandria, La.

C. W. SMITH, chief car inspector of the Missouri Pacific at Little Rock, Ark., has been appointed car foreman, with headquarters at Texarkana, Ark., succeeding J. B. Ferrell.

W. C. STENASON, general air brake inspector of the Canadian Pacific at Winnipeg, Man., has been promoted to master car builder of the Western lines, with headquarters at the same point, succeeding T. G. Armstrong, who retired from active service on January 1. Mr. Stenason was born on February 12, 1874, at Willesden, England. At the age of 17 he entered railway service in the mechanical department of the Michigan Central at St. Thomas, Ont. In May, 1892, he was appointed a foreman on the installation of track tanks and pumping machinery on the Canada Southern division and in January, 1894, he entered locomotive service. Mr. Stenason returned to the mechanical department in March, 1896, and in December, 1897, during the operation of the Toronto, Hamilton & Buffalo by the Michigan Central, he was transferred to Hamilton, Ont., where he remained in charge of the installation, maintenance and operation of air brakes, until October 1, 1907, when he was appointed assistant air brake inspector of the Eastern lines of the C. P. R. On January 1, 1915, he was promoted to general air brake inspector of the Western lines of the Canadian Pacific.

Walter G. Stenason

B. H. MCKERRAL, car foreman of the Chicago Great Western at Chicago, who was promoted to superintendent of the car department with headquarters at Oelwein, Iowa, was born May 27, 1884 at Marshalltown, Iowa. He received his early education at the elementary schools and high school in Marshalltown, entering the service of the Chicago Great Western on March 8, 1899. After working mostly in the car and locomotive departments in various capacities as car repairer, locomotive fireman and machinist, Mr. McKerral went to the American Locomotive Company at Richmond, Va., as final inspector during the period from February, 1917 to April 1919. September, 1919, he returned to the Chicago Great Western as general car foreman at Chicago, which position he held until the time of his recent appointment.

ELECTRIC DRILLS.—Specifications for drills of ¼ in. size and up are set forth in the electric drill catalogue of the Goodell-Pratt Company, Greenfield, Mass.

CRANES.—The Whiting Corporation, Harvey, Ill., describes in catalogue No. 209 cranes for use in railroad shops, power houses, foundries and other industries. Clearance figures, based on Whiting Standard construction; viz., notched girders and M.C.B. type end trucks, have been compiled in this catalogue for the special benefit of engineers and others who design buildings in which cranes are to be used.